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An Illustrated Weekly Journal.

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Chancery Division.
Mr. Justice YOUNGER.
In the Matter of BROWETT LINDLEY and CO. (Limited and Reduced),
and
In the Matter of THE COMPANIES (CONSOLIDATION) ACT, 1908.

Notice is Hereby Given that

the order dated the 6th June, 1916, confirming the reduction of capital of the above-named company from £120,000 divided into 60,000 6% per cent. Cumulative Preference shares of £1 each and 60,000 Ordinary shares of £1 each of which 50,000 Preference shares and 50,000 Ordinary shares have been issued and are fully paid to £107,500 consisting of 60,000 Preference shares of £1 each, 10,000 Ordinary shares of £1 each, and 50,000 Ordinary shares of 15s. each and the minute approved by the Court showing with respect to the capital of the company as altered the several particulars required by the above-mentioned Act was registered by the Registrar of Joint Stock Companies on the 20th day of June, 1916. And Further Take Notice that the said minute is in the words and figures following: "The capital of Browett Lindley and Co., Limited and Reduced is henceforth £107,500 divided into 60,000 Preference shares of £1 each, 10,000 Ordinary shares of £1 each, and 50,000 Ordinary shares of 15s. each reduced from the original capital of £120,000 divided into 60,000 Six per cent. Cumulative Preference shares of £1 each and 60,000 Ordinary shares of £1 each." At the date of the registration of this minute (a) 50,000 of the said Preference shares of £1 each Nos. 60,001 to 110,000 inclusive have been issued and the sum of £1 a share has been and is to be deemed to be paid up thereon (b) 50,000 of the said Ordinary shares of 15s. each Nos. 1 to 50,000 inclusive have been issued and the sum of 15s. a share has been and is to be deemed to be paid up thereon (c) the remaining 10,000 Preference shares of £1 each to be Nos. 110,000 to 120,000 inclusive and the remaining 10,0000 Ordinary shares of £1 each to be Nos. 50,001 to 60,000 inclusive have not been issued and nothing has been or is to be deemed to be paid up thereon.
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LITERATURE.

1. *Sulphuric Acid and Sulphur Products.* By GEOFFREY MARTIN, D.Sc., and Major J. LOUIS FOUCAR, B.Sc., late Assistant Manager of the Beckton Gas Works. London: Crosby Lockwood and Son. [Price 7s. 6d. net.]
2. *Chlorine and Chlorine Products.* By GEOFFREY MARTIN, with a chapter on Recent Oxidising Agents, by G. W. CLOUGH, B.Sc. London: Crosby Lockwood and Son. [Price 7s. 6d. net.]
3. *The Salt and Alkali Industry.* By GEOFFREY MARTIN, STANLEY SMITH, M.Sc., and F. MILSOM, B.Sc. London: Crosby Lockwood and Son. [Price 7s. 6d.]

(1) ONE cannot doubt that if Major Foucar had lived the treatment of this important subject would have been more systematic and comprehensive. Instead of the carefully digested arrangement that we should have expected from so competent an authority we have rather a collection of material from which a very desirable treatise might have been constructed. The attention of the author to his military duties, and his sad death on the battlefield, explain what is lacking, and at the same time disarm criticism. The Editor, Dr. Geoffrey Martin, is responsible for the use made of the material left by Major Foucar. He has, too, considerably extended the scope of the volume, but as it now occupies less than seventy pages, we imagine the contribution of the late Major must have been comparatively slight.

The book consists of four chapters of very unequal length, dealing respectively with the sulphur industry, sulphuric acid, the manufacture of sulphur dioxide, and of other sulphur compounds, including carbon disulphide, sodium thiosulphate, sodium hyposulphite, and sulphuretted hydrogen, the whole information concerning the last being compressed within less than a dozen lines.

The chapter on the sulphur industry we find rather repellant, and it might have been treated in an attractive way that would have aroused the enthusiasm of the student, for whom, we imagine, this treatise is prepared. The Friesch process of winning sulphur from the mines in Louisiana, furnishing a quantity that dominates the world's markets, is one of the happiest achievements of modern technical science, but one would hardly gather that opinion from the bald account supplied. Historically, of course, the working of sulphur in the Sicilian mines has a romantic and lurid side, which may be suggested to some by the mysterious word "calcarone," introduced apparently to excite rather than to satisfy curiosity.

In the second chapter the alternative methods of production by the "chamber" and "contact" processes are adequately described, but in the former we miss allusion to some of the recent improvements that have been effected in America, and in the latter the vexed question of the action of catalysers and of "poisons," notwithstanding the uncertainty attaching to the whole subject, might have been more suggestively treated. There is ample room for increased intelligent manipulation in this process, on which the authors might have insisted in these days, when the outcry is for greater scientific education, since some of the failures to get the best results may be traced to the want of technical skill and knowledge on the part of the operator. It is fortunate that there are separate fields open for the employment of acid produced by either process: the manufacturers of fertilisers can absorb the weaker and less pure acids, while the explosive and colour industries need the more concentrated and fuming acids that are given by the "contact" process. As it is the rivalry is keen, and so far the competition has been of advantage to the "chamber" process, resulting in the introduction of important economies both in plant and procedure. The authors have not much to say on the cubical space required in the several circulating systems now in favour, a point of considerable importance. In the Falding Chambers it is stated, though with some suggestion of doubt, that no more than 6 to 7 cub. ft. is required per lb. of sulphur burned in twenty-four hours. In another patent, that of the Brown Tower-Chamber, not fully described, this cubical space is reduced to 4 ft. These figures prove the increased attention given to economical production, and the consequent diminished initial cost of works construction.

The remaining chapters on the manufacture of anhydrous sulphur dioxide, carbon disulphide, &c., are disappointing from their brevity. With regard to the former, the Hamisch and Schroeder's process is described, and of the latter the electrical method of Taylor. It is stated that a single furnace is capable of producing from 14,000 lb. to 25,000 lb. of CS_2 in twenty-four hours. The non-professional mind must wonder how so much of a substance rarely seen can be consumed. The greater part probably goes into the rubber industry, and here, as elsewhere, is employed as a solvent.

(2) The chlorine industry has undergone notable transformations, and the end is not yet. The Weldon process, whose main feature consists in the oxidation of hydrochloric acid by means of manganese dioxide, was hailed at its inception as a welcome revolution, and the saviour of the Leblanc soda industry. Its pride of place had to meet a doughty competitor in the method proposed by Deacon and Hurter, who proposed to utilise the oxygen of the atmosphere to oxidise hydrochloric acid to chlorine and water. Against this formidable foe the Weldon process has weakened in favour, while that of Deacon, though improved by Hasenclever on the mechanical side, and by Falckenstein and others on the thermodynamical, has a hard struggle to maintain its own against the electrolytic methods that have received great development both in America and Germany. The prize is great, the production of chlorine is enormous, for its use is wide and various, and it is to be regretted that our persistent neglect of electrolytic methods is jeopardising our position in the whole field of chemical industry.

Under these circumstances there was room for a treatise at once stimulating and comprehensive, but we are afraid that Dr. Martin and his coadjutors have missed an opportunity of impressing the student world with the commercial and chemical importance of the subject. They seem to have been afraid to give themselves scope. They knew perfectly well that in a book of 100 pages, amply illustrated as this is, it would be impossible to treat the subject exhaustively, or even adequately. On the other hand, the information is not put in a form that would hold the attention of the ordinary reader, who, without previous preparation, hopes to get an insight into the procedure of chemical technology.

The scheme of the book includes the description of the growth and present position of the chlorine industry, and of the manufacture of bleaching powder. As closely connected, the hypochlorites, the chlorates and perchlorates come under review. A very considerable amount of information is supplied, and would have been more useful if the several chapters had been extended; but unfortunately the author has dwarfed these to make room for sections on the industrial uses of bromine and iodine, and added descriptions of the manufacture of hydrochloric and hydrofluoric acids. Finally, Mr. Clough supplies a short chapter on some modern oxidising agents—the peroxides, persulphates, and percarbonates. Some of these find application as bleaching agents, others have a limited use in photography, but generally their technical importance is slight, and has little connection with the subject matter.

Naturally the interest and the merit of the various chapters are unequal, but we welcome every effort that insists upon the adoption of improved technical methods, and reproves our shortcomings in the past in the hope of destroying our complacency and quickening our lethargy. On this ground, the description of the various processes employed in the electrolysis of alkali chlorides is particularly valuable. It is painful to read that in Germany two-thirds of the bleaching powder required is made from electrolytic chlorine, that the United States is developing the industry in giant strides, but that in the United Kingdom barely a beginning has been made. The activity in Germany, of course, dates before the war, while in America the loss of the German market has promoted development, and demonstrated the necessity of relying upon home production. Pressed on both east and west by active competitors; hide bound by stereotyped methods, and cramped by fiscal shibboleths, our chemical trade is in a parlous state.

(3) The last addition to the Manuals of Chemical Technology has reference to the salt and alkali industry, and must in some measure overlap the ground covered by the last-mentioned manual, for the supply of salt reacts on the production of chlorine, as it does on soap and glass and other materials. The repeal of the salt tax was the signal for starting the first Leblanc soda factory, and a whole network of chemical industries. Cheap sulphuric acid was called for in large quantities, and with this demand hydrochloric acid became a waste product in the salt-cake furnaces, tending later to promote the chlorine industry and the manufacture of bleaching powder. So much are these several industries interlocked that the chapter on the manufacture of hydrochloric acid is reproduced from the earlier work without alteration. As this chapter is typical of the whole, it goes without saying that the faults and the merits to which we have called attention are repeated here.

The remaining chapters deal with the manufacture of sodium sulphate (salt-cake) and of sodium carbonate as produced by the Leblanc and ammonia-soda processes. This latter treatment, which has operated disastrously, nearly annihilating the Leblanc process, has in its turn to suffer keen competition both from electrolysing of the alkali chlorides and the exploitation of the inexhaustible natural deposits of soda in East Africa. It is satisfactory to know that a company has been formed to mine these deposits, and that factories are being erected in England and in the East to refine the raw material, and to convert it into other soda compounds. The authors are of opinion, however, that the high state of economic efficiency to which the Solvay process has been brought will enable it to resist the competition threatened by the exploitation of the raw material, handicapped as the latter is by the cost of freight and carriage. The "Stassfurt Industry," and the chapter on potassium salts, with which the book closes, are deserving of fuller treatment, both on account of their innate interest and of their technical importance.

BOOKS RECEIVED.

The Canada Year-Book, 1914. Ottawa: J. de L. TACHÉ, King's Printer. [Price 1 dol.]

Live-Load Stresses in Railway Bridges, with Formulas and Tables. By GEORGE E. BEGGS, A.B., C.E. New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Limited. [Price 8s. 6d. net.]

The Naval Architect's and Shipbuilder's Pocket-Book. By CLEMENT MACKROW and LLOYD WOOLLARD. Eleventh Edition, thoroughly revised, with a section on *Aeronautics.* London: Crosby Lockwood and Son. [Price 12s. 6d. net.]

United States Geological Survey. Bulletin 593: *The Fauna of the Batesville Sandstone of Northern Arkansas.* By GEORGE H. GIRTY. Bulletin 595: *Fauna of the So-Called Boone Chert, near Batesville, Arkansas.* By GEORGE H. GIRTY. Bulletin 598: *Fauna of the Boone Limestone at St. Joe, Arkansas.* By GEORGE H. GIRTY. Bulletin 602: *Anticlinal Structure in Parts of Cotton and Jefferson Counties, Oklahoma.* By CARROLL H. WEGEMAN. Bulletin 609: *The Fractional Precipitation of Some Ore-Forming Compounds at Moderate Temperatures.* By ROGER C. WELLS. Bulletin 611: *Guide-Book of the Western United States.* Part A.—*The Northern Pacific Route.* By MARIUS R. CAMPBELL and others. Bulletin 613: *Guide-Book of the Western United States.* Part C.—*The Santa Fe Route.* By N. H. DARTON and others. Bulletin 614: *Guide-Book of the Western United States.* Part D. *The Shaster Route and Coast-Line.* By J. S. DILLEN and others. Bulletin 622: *Mineral Resources of Alaska; Report on Progress of Investigations in* 1914. By ALFRED H. BROOKS and others. Washington: Government Printing Office.

La Guerre Moderne et Ses Nouveaux Procédés. Par DANIEL BELLET et WILL DARVILLÉ. Illustré de 153 gravures. Paris: Hachette et Cie.

Alternating Currents: Their Elements Explained, and their Calculation Effected without the Use of Hyperbolic Functions. By H. R. KEMPE, M. Inst. C.E., M.I.Mech.E., M.I.E.E. London: Crosby Lockwood and Son. [Price 3s. 6d. net.]

The Life of Benjamin Disraeli, Earl of Beaconsfield. By GEORGE EARLE BUCKLE. Vol. IV., 1855–1868. London: John Murray. [Price 12s. net.]

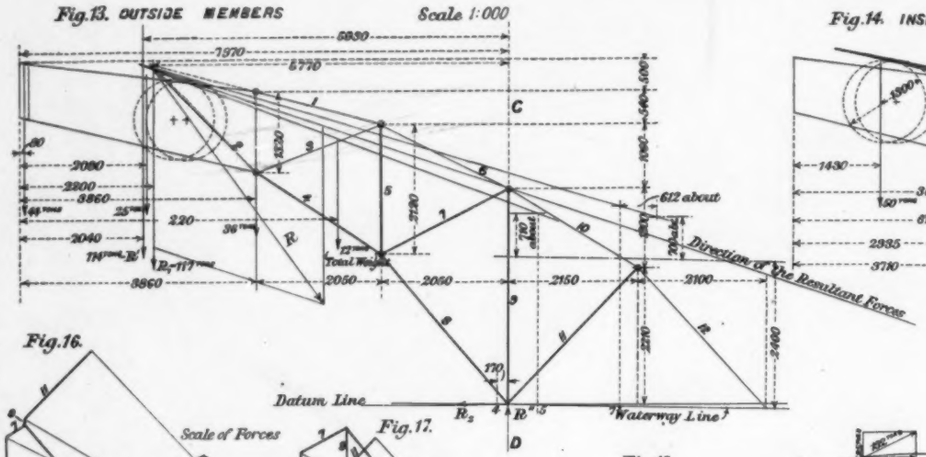
THE BRAZILIAN SUBMARINE DEPÔT MOTOR-SHIP "CEARA."

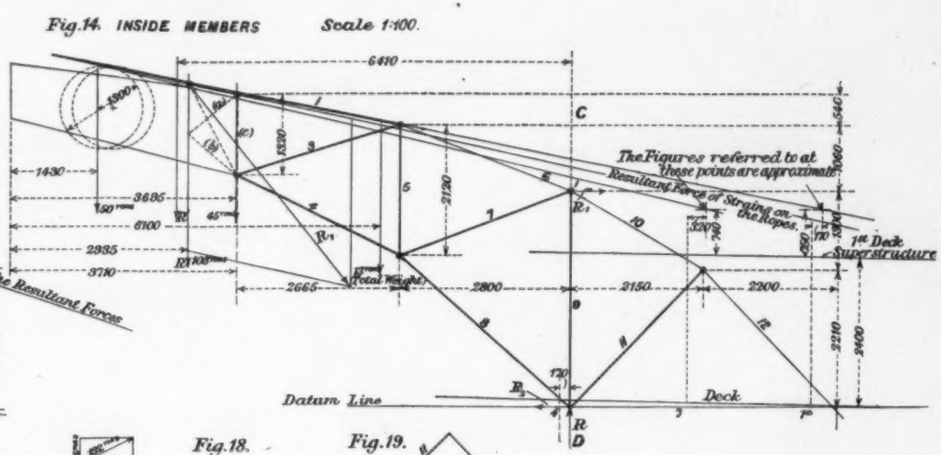
(Concluded from page 569.)

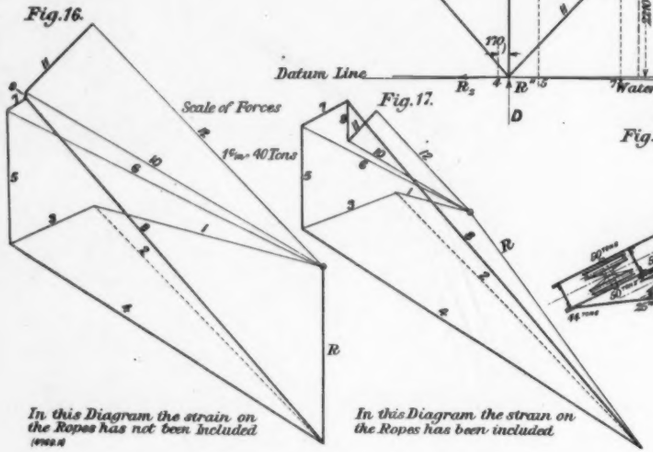
WE complete our illustrations of this interesting ship by publishing on Plate LII., accompanying this issue, drawings of the two cranes fitted at the stern in order to raise submarine boats, either for

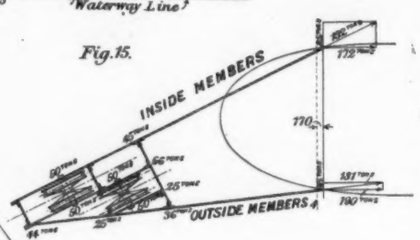
SUBMARINE DEPÔT SHIP "CEARA;" DIAGRAMS AND DATA OF STRESSES ON 200-TON CRANES FOR LIFTING SUBMARINE-BOATS.

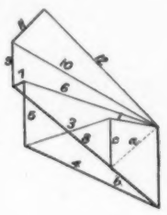
CONSTRUCTED BY THE FIAT SAN GIORGIO COMPANY, SPEZIA, ITALY.

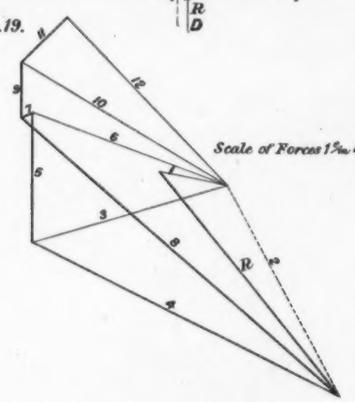












Tons.	Tons-M.
44 × 0.08 =	3.520
25 × 2.09 =	52.250
36 × 3.86 =	138.960
12 × 5.22 =	62.640
117	257.370

R = 117 tons

Supposing the crane to be fixed at line C D. (Fig. 13).

44 × 0.08 =	3.52
25 × 2.09 =	52.25
36 × 3.86 =	138.96
* 9 × 4.20 =	37.80
114 = R¹	232.53

* Weight of section C D at the end

$R_1 = R_2 = \frac{114 \times 5.93}{3.510} = 192$

Tons	Tons-M.
50 × 1.43 =	71.500
45 × 5.645 =	166.270
13 × 6.100 =	79.300
108	317.070

R = 108 tons

Supposing the crane to be fixed at line C D. (Fig. 14).

50 × 1.45 =	71.50
45 × 3.695 =	166.27
*10 × 5.000 =	50.00
105 R¹	287.77

* Weight of section C D at the end

$R_1 = R_2 = \frac{105 \times 6.41}{3.51} = 191$ tons

Outside Members. Fig. 16.

	Number of Elements	Maximum Load (Kilogs.)	Sectional Area per sq. mm	Stresses per sq. mm		Remarks.
No.	1	152,000	27,400	5.5	Kg	Tension
,,	3	63,000	8,200	7.6	,,	,,
,,	4	245,000	46,500	5	,,	Compress.
,,	5	89,000	8,200	10	,,	,,
,,	6	231,000	27,400	8.4	,,	Tension
,,	7	15,000	8,200	2	,,	Compress.
,,	8	299,000	46,500	6.5	,,	,,
,,	9	4,000	20,700	1	,,	,,
,,	10	225,000	27,400	8	,,	Tension
,,	11	63,000	11,400	5.5	,,	Compress.
,,	12	219,000	27,400	8	,,	Tension

Stresses from diagram Fig. 16

Outside Members. Fig. 17.

For designing the reciprocal diagram it has been assumed that the strain R is divided in two equal parts on directions (a) (b).

Scale of forces 1 cm. = 20 tons.

Number of Elements	Maximum Load (Kilog.)	Sectional Area per sq. mm	Stresses per sq. mm		Remarks.
No. 1	51,000	27,400	2	Kg	Tension
,, 3	66,000	8,200	8	,,	,,
,, 4	264,000	46,500	6	,,	Compress.
,, 5	67,000	8,200	8	,,	,,
,, 6	124,000	27,400	5	,,	Tension
,, 7	35,000	8,200	4	,,	Compress.
,, 8	297,000	46,500	6.5	,,	,,
,, 9	25,000	20,700	1	,,	,,
,, 10	93,000	27,400	4	,,	Tension
,, 11	26,000	11,400	2	,,	Compress.
,, 12	91,000	27,400	4	,,	Tension

Stresses from diagram Fig. 17

Inside Members. Fig. 18.

	Number of Elements	Maximum Load (Kilog.)	Sectional Area per sq. mm	Stresses per sq. mm		Remarks.
No.	1	65,000	27,400	2	Kg	Tension
,,	3	117,000	8,200	14	,,	,,
,,	4	95,000	46,500	2	,,	Compress.
,,	5	85,000	8,200	10	,,	,,
,,	6	87,000	27,400	3	,,	Tension
,,	7	18,000	8,200	2	,,	Compress.
,,	8	254,000	46,500	5.4	,,	,,
,,	9	55,000	20,700	2.6	,,	Tension
,,	10	223,000	27,400	8	,,	Compress.
,,	11	60,000	11,400	6	,,	,,
,,	12	217,000	27,400	7.9	,,	Tension

Stresses from diagram Fig. 18

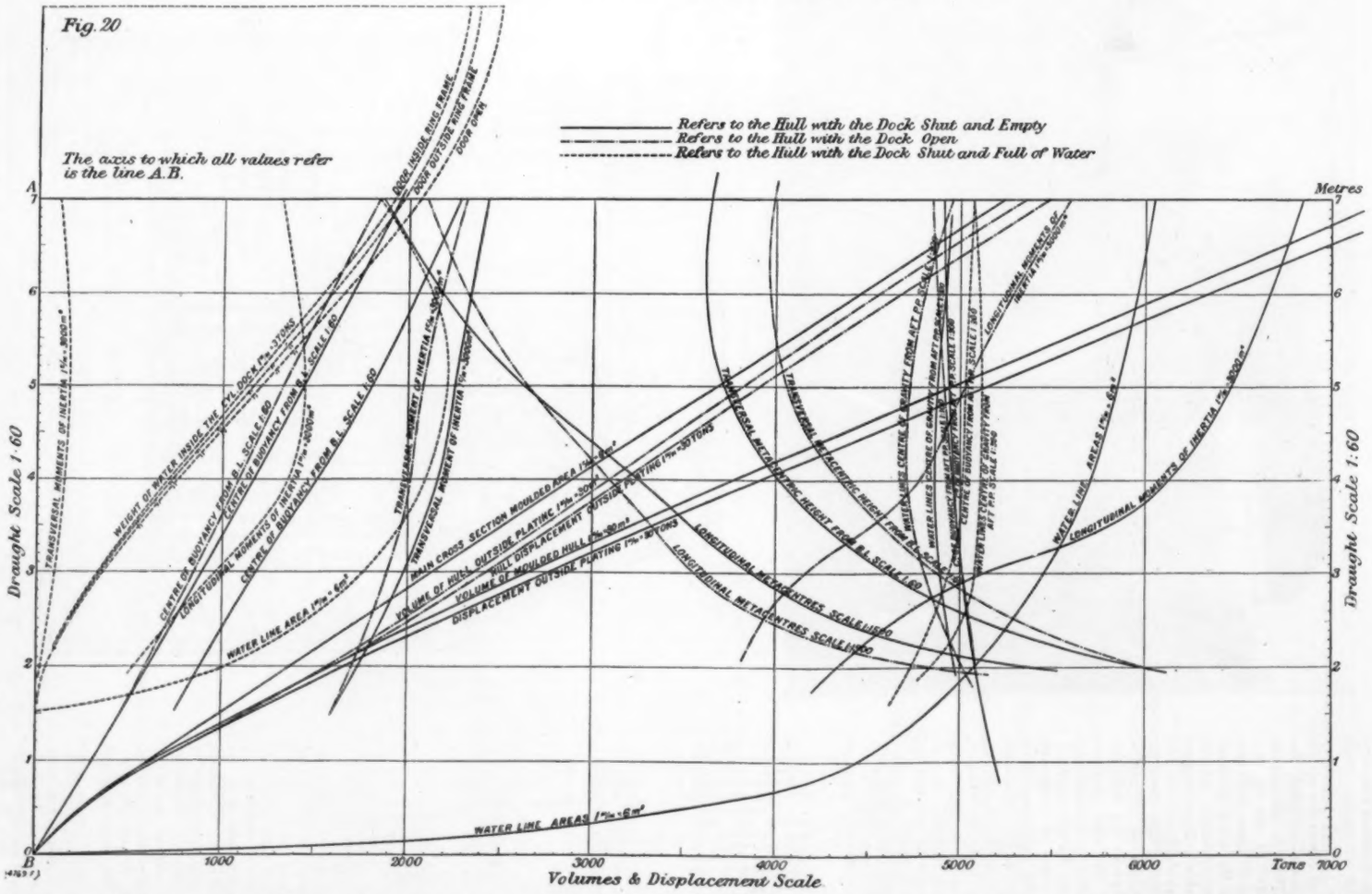
Inside Members. Fig. 19.

	Number of Elements	Maximum Load (Kilogs.)	Sectional Area per sq. mm	Stresses per sq. mm		Remarks.
No.	1	45,000	27,400	2	Kg	Tension
,,	3	130,000	8,200	15	,,	,,
,,	4	223,000	46,500	5	,,	Compress.
,,	5	84,000	8,200	10	,,	,,
,,	6	135,000	27,400	5	,,	Tension
,,	7	16,000	8,200	2	,,	Compress.
,,	8	276,000	46,500	6	,,	Tension
,,	9	36,000	20,700	2	,,	Compress.
,,	10	156,000	27,400	6	,,	Tension
,,	11	42,000	11,400	4	,,	Compress.
,,	12	152,000	27,400	6	,,	Tension

Stresses from diagram Fig. 19

SUBMARINE DEPÔT SHIP "CEARA;" CURVES OF STABILITY CONDITIONS UNDER VARIOUS LOADS AND TRIMS.

CONSTRUCTED BY THE FIAT SAN GIORGIO COMPANY, SPEZIA, ITALY.



inspection or in connection with the process of docking them in the cylindrical dock provided in the ship, as illustrated and described in our preceding article. The external members of the crane structure, fully dimensioned, are shown in Fig. 10, the inside structure in Fig. 11, and the plan on Fig. 12. The structural details on the illustrations are so complete that there is no need here to enlarge upon them. Each of the two cranes has a lifting capacity of 200 tons through a distance of 120 ft. in thirty minutes. Each has two winches, with the necessary winding gear, and 100-horse-power electric motors, on the bridge deck, as shown in Fig. 5, on the two-page plate accompanying our issue of the 16th inst.; on this deck can also be seen the necessary purchase-blocks, which travel along the deck.

On page 614 there are reproduced diagrams and tabular statements of the stresses on the important members of the outer and inner elements of the crane structure. These may be studied with much interest. Comment here is unnecessary.

Hawse-pipes and anchors are provided aft as well as forward, in order that the ship may be kept as steady as possible when a submarine-boat is being docked, or when the bow or stern of the submarine is being raised for examination of propellers, rudders, hydroplanes, &c.

For the duties of supplying the units of the submarine flotilla, 600 tons of fuel oil is carried—sufficient for 4000 nautical miles at 10 knots speed of the depôt ship, and completely to re-charge the bunkers of the six submarines on four occasions. On this depôt ship are also installed two auxiliary Diesel engines, each developing 225 brake horse-power at 300 revolutions per minute, built by the Fiat San Giorgio Company, of Turin, and of the same type as the main engines of the Ceara, and the propelling Diesel engines of the submarines. It may here be emphasised that all the Diesel engines of the depôt ship and of the submarines are of the same type, so that the equipment of the depôt ship serves for instructional purposes for the officers and the crews of the submarine boats. Each of these auxiliary engines drives three dynamos, each supplying current to a battery on board the depôt ship, the units of which battery serve as spares for the batteries of the submarine. There are, therefore, six dynamos in all, and the current generated by four is sufficient

to supply the four 100-horse-power electric motors for use for the main lifting cranes. The other two dynamos can be run as motors from the depôt ship's batteries and drive the four dynamos, thus supplying the current for the motors working the main cranes, in the event of a breakdown of the auxiliary Diesel engines. These dynamos also serve to charge the batteries of the submarines when desired.

For filling the compressed-air reservoirs of the submarines, three compressors are provided, two with a capacity of 15 litres (0.53 cub. ft.) per minute, compressed to 170 atmos. (2420 lb. per sq. in.), and electrically driven; one of 20 litres (0.70 cub. ft.) per minute, compressed to the same pressure, and steam driven from the donkey boiler. Driven through a clutch from the auxiliary Diesel engines (each of 225 brake horse-power) there are also two compressors, each of a capacity of 275 litres per minute (9.8 cub. ft.), compressed to 75 atmos. (1070 lb. per sq. in.), as stand-bys for the main fuel injection air-compressors of the main engines. The capacities per minute of these compressors are stated in cubic feet of air at the delivery pressure. The donkey boiler fired with heavy oil evaporates two tons per hour, and serves the compressor aforementioned, a distiller of 200 litres (45 gallons) per hour capacity, and also supplies the ship's laundry. A refrigerating carbon-dioxide plant is installed, complete with brine pump, &c., all electrically driven; and for the storage of foods 43 cub. m. (1500 cub. ft.) space is insulated with cork-and fir-wood.

TABLE I.—*Various Trim and Stability Conditions of Ship.*

	1st Condition. Ship with Full Load during the Raising of a Submarine. Dock Shut and Empty. Raising by Means of the Two Aft Cranes.	2nd Condition. Ship in Same Condition as Case 1, Ready to Dock a Submarine for Transport, Overhaul, or Testing. Dock Open.	3rd Condition. Ship with Full Load. Testing a Submarine by Water Pressure. Dock Shut and Full of Water.
Assumed weight of submarine to be lifted ... tons	400	—	—
Water inside the forward ballast-tank... ... tons	55	—	—
Displacement under above conditions ... ... tons	4615	4130	6480
Mean draught .. ft.	15.1	17.4	20.10
Centre of buoyancy from aft perpendicular... ft.	162	161	161
Centre of buoyancy above base line ... ... ft.	8.85	9.18	11.30
Centre of gravity from aft perpendicular ... ft.	147	160.5	155.5
Centre of gravity above base line ... ... ft.	21.1	—	17.1
Transverse metacentre above centre of buoyancy ft.	16.0	17.05	18.4
Longitudinal metacentre above centre of buoyancy ft.	470	413	347.5
Draught difference ... in.	10.35*	—	—
Transverse metacentric height ... ... in.	3.77	8.65	6.3

* With vessel in this condition, both cranes lifting, the draught at the stern is greater than that forward.

It will readily be appreciated that the design of so unique a vessel presents many problems to the naval architect, and the thorough way in which the stresses have been estimated, and the ample and efficient disposition of material, can be seen from the tabular statements and sectional drawings in our first article, and the particulars of loads and stresses in the various members of the crane reproduced in the drawings and tables accompanying this article. Not only must the various loads and stresses at the many sections of the ship be carefully estimated, but the draught and stability in all possible conditions must be provided for. The three principal conditions are:—

1. With the ship carrying full load, the dock-door shut, the dock empty, and a submarine being raised by the two aft cranes.

2. The ship in the same state as Case 1, with the dock-door open; and

3. With the submarine docked, and the dock-door shut.

In this latter case the submarine may be surrounded by water under pressure for the purpose of making an external pressure test on its hull. Table I. gives the various figures for these three conditions. The curves in Fig. 20, on page 615, show the variations in the leading figures, moments and centres for the above three conditions, and for the transition stages. The variation in slope of the curves dealing with longitudinal centres will be noted, and is due to the particular construction. It will be seen from the particulars we have given that this ship is a complete unit, and forms a most interesting example of modern Italian naval architecture, not only in its general arrangement and in the careful way in which constructional details have been worked out, but also in the completeness and modern character of its main machinery and auxiliary equipment. The vessel, we may add, was designed by Ing. Laurenti, the designer to the Fiat San Giorgio Company, of Spezia.

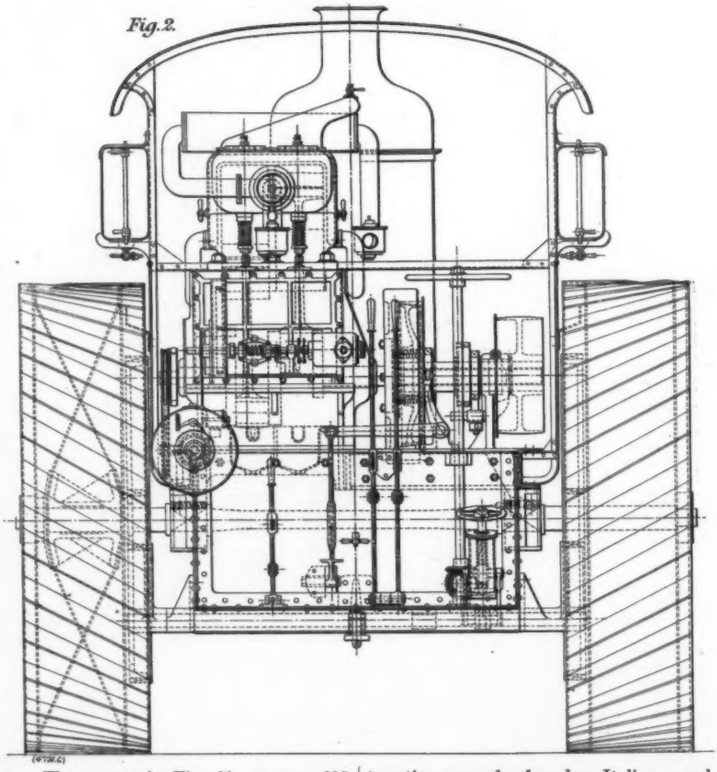
THE OMNITRACTOR AT THE MANCHESTER SHOW.

CONSTRUCTED BY THE OMNITRACTOR SYNDICATE, LIMITED, LONDON.

(*For Description, see opposite Page.*)

FIG. 1.

Fig. 2.



THE OMNITRACTOR AT THE MANCHESTER SHOW.

CONSTRUCTED BY THE OMNITRACTOR SYNDICATE, LIMITED, LONDON.

Fig. 3.

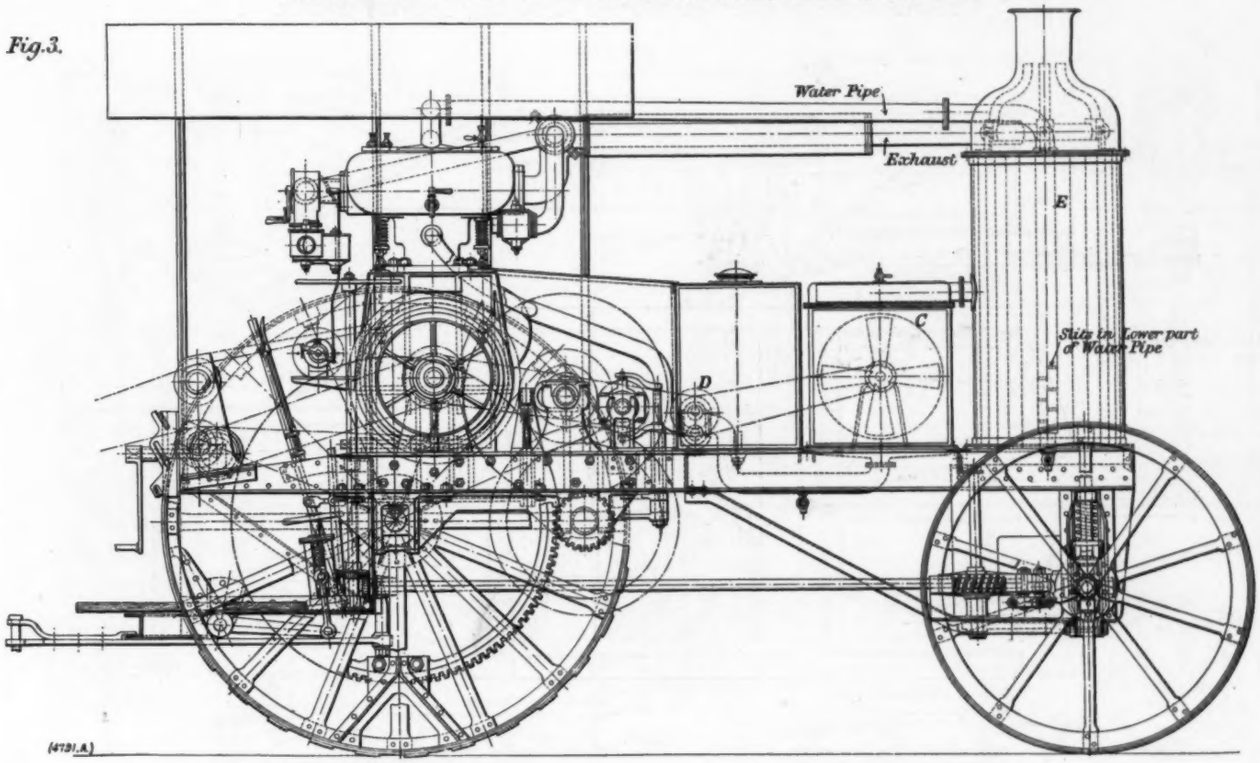
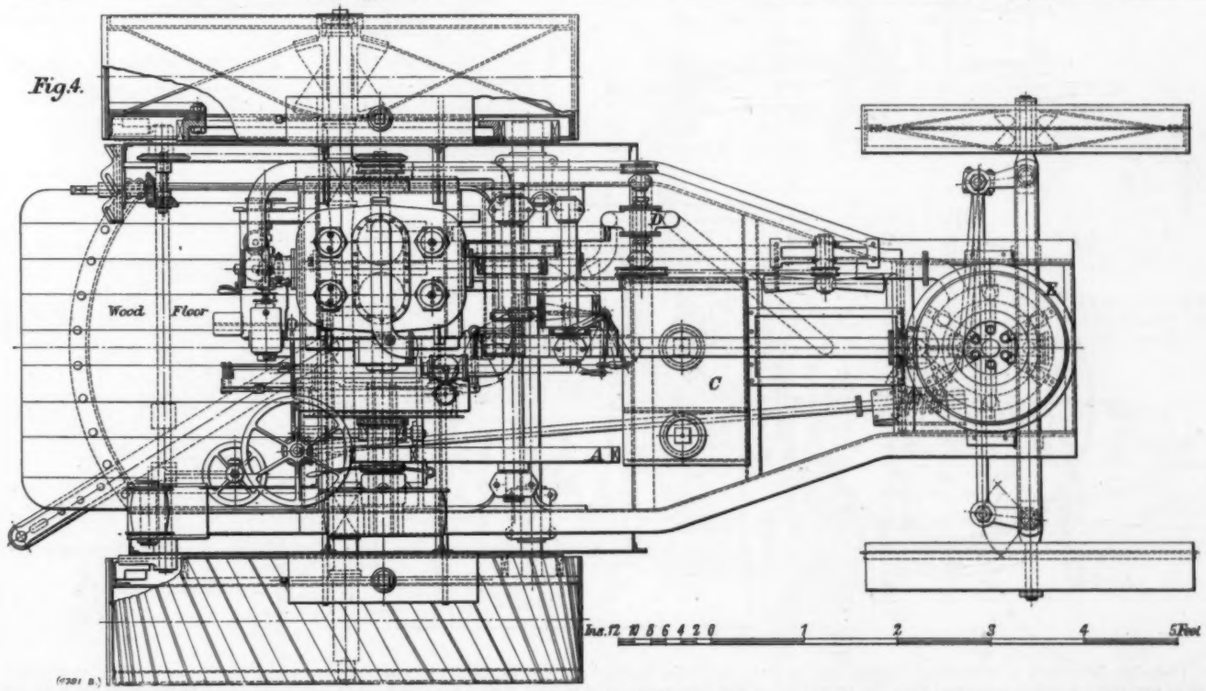


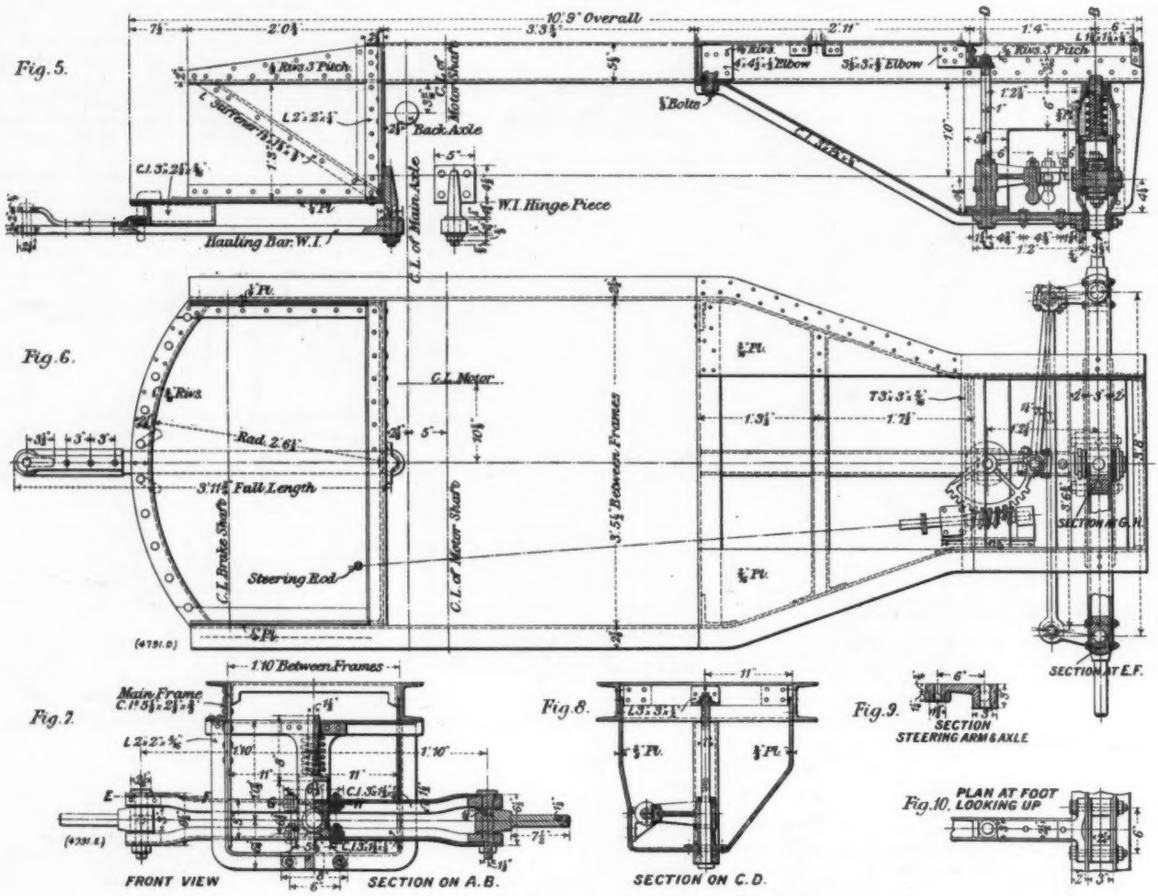
Fig. 4.

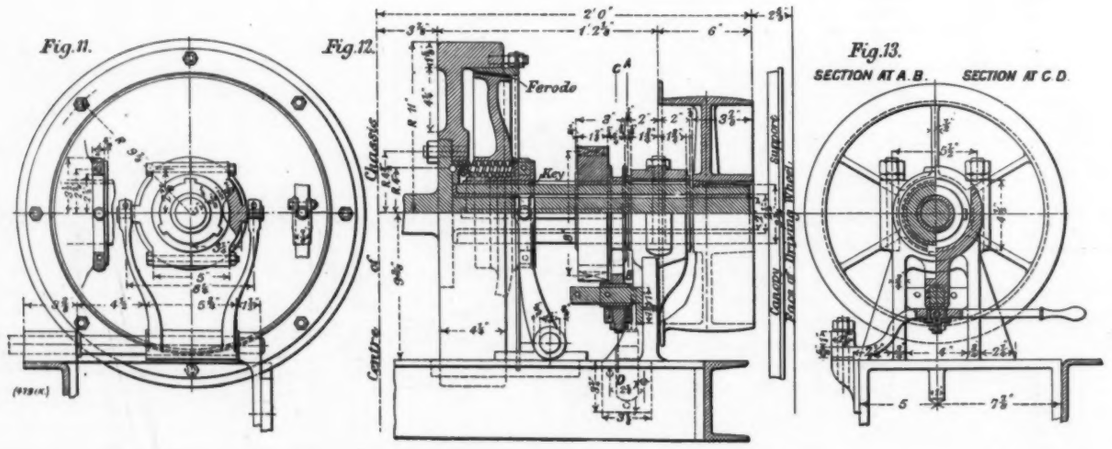


THE Omnitractor Syndicate, Limited, of 18–19, Great St. Helens, London, E.C., exhibit in the Royal Agricultural Society's Show at Manchester the tractor which we illustrate in detail on pages 616 to 619. This tractor, which is of the four-wheeled type, weighs about 3¼ tons, and is capable of exerting a tractive effort of over 2,000 lb. The general arrangement of the implement is well shown in Figs. 1, 2, 3 and 4, annexed. The engine provided has two cylinders, 6 in. in diameter by 9-in. stroke, and is capable of developing 30 brake horse-power when running at its designed speed of 750 revolutions per minute. When in operation it is intended to be started up on petrol, but when warmed up with this fuel it will run on paraffin, water injection being fitted to obviate any danger of pre-ignitions. As our engravings show, the engine is mounted near the rear of the chassis, all the controlling levers being arranged conveniently to the hand of the driver. The chassis, which is illustrated separately in Figs. 5 to 10, page 618, is constructed entirely of merchant sections. The three-point suspension principle has been adopted in mounting the frame on the wheels, thus avoiding any possibility of distortion when rough ground is traversed. The front axle is supported on a helical spring, as best seen in Fig. 7, and, as indicated in the rear view of the tractor, Fig. 2, the back axle is also spring-mounted. In both cases the wheels are loose on the axles. Ackerman steering operated by worm and sector is fitted, the details of this being fully shown in Figs. 5 and 6. The front axle, moreover, is centrally pivoted, making the steering particularly easy. The wheels are constructed from merchant steel and iron without the use of special forgings. The drivers are 5 ft. in diameter and 16 in. wide, whilst the leading wheels measure 3 ft. 6 in. by 8 in. The construction of the driving wheels is shown in detail in

THE OMNITRACTOR AT THE MANCHESTER SHOW.

CONSTRUCTED BY THE OMNITRACTOR SYNDICATE, LIMITED, LONDON.





Figs. 14 to 16. The drive is by external toothed gear wheel of cast steel, which is supported from the wheel rim by four brackets built up of plates and angles. The hub is a steel casting. A gun-metal cap, as shown in Fig. 16, prevents access of dirt to the journal.

The whole of the transmission gear is of the spur-wheel type, bevels being avoided of set purpose, as such wheels require the alignment to be accurately maintained if they are to work well, whilst spur-gearing is much less sensitive to the results of injuries such as might result, for example, from slight collisions. With this object in view, the engine has been arranged transversely to the frame, as shown in the end elevation and plan of the tractor, Figs. 2 and 4. A clutch is fitted inside the flywheel and can be thrown in and out of gear by a pedal. The moving part of the clutch is mounted on a sleeve which runs loose on the engine shaft, as best seen in the detail drawings, Figs. 11 to 13, above. At its outer end this sleeve has keyed to it a belt pulley (see Fig. 12) which can be used for driving any kind of farm machinery.

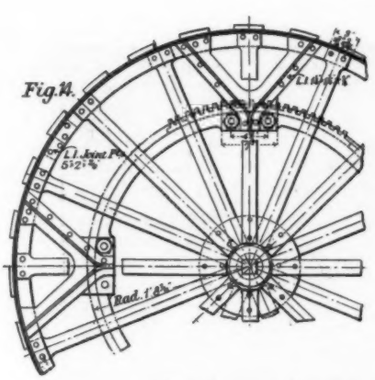
The construction of the clutch is clearly shown in Fig. 12. It is maintained in gear by means of the six spiral springs shown in the drawing, and is thrown out by moving it to the left, so as to compress these springs. The thrust is carried by a ring of ½-in. steel balls, as indicated in Fig. 12.

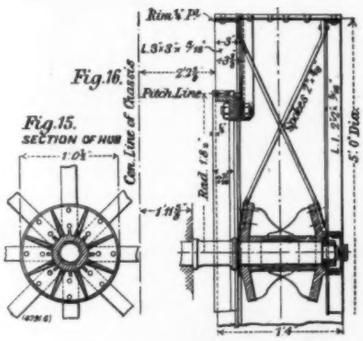
One of the friction surfaces is a lining of ferodo, and wear can be taken up by screwing the back plate further into the wheel by means of the studs and nuts provided.

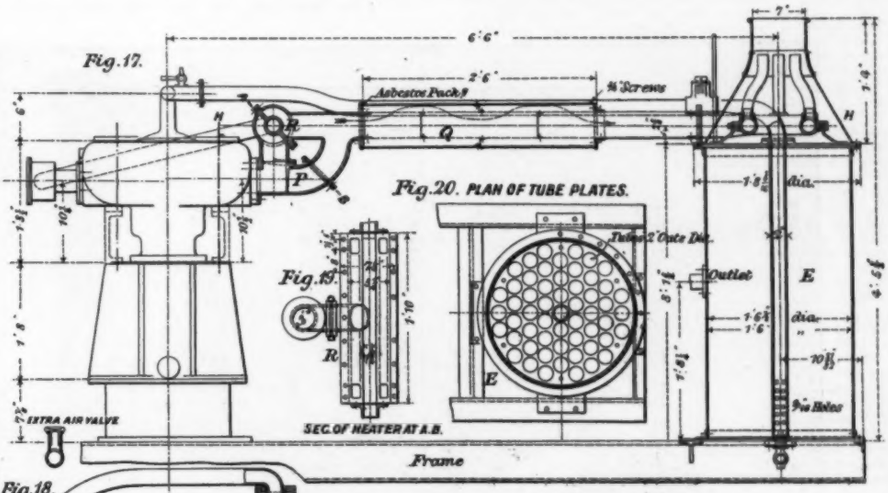
It will be seen that a sliding pinion is mounted on the clutch-sleeve; with this pinion in the position shown in Fig. 12 it gears with the wheel A, Fig. 4, and in this way the engine drive is transmitted to the differential and thence to the road wheels. By sliding the pinion out of engagement, however, by means of the handle lever and collar provided, the engine is left free for driving other machinery by means of the belt pulley already mentioned. The engine is provided with a governor, as indicated in the rear view of the tractor, Fig. 2, and is accordingly well fitted for the service

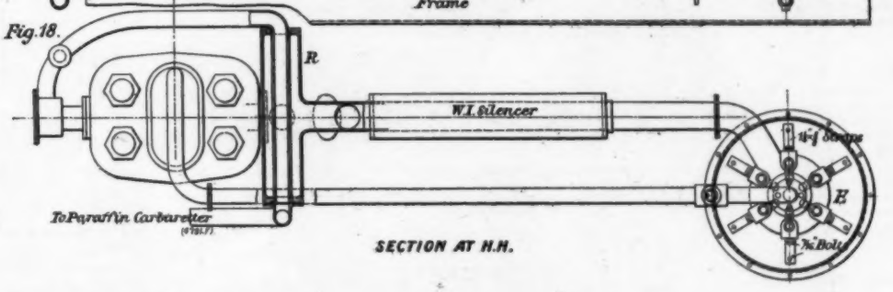
THE OMNITRACTOR AT THE MANCHESTER SHOW.

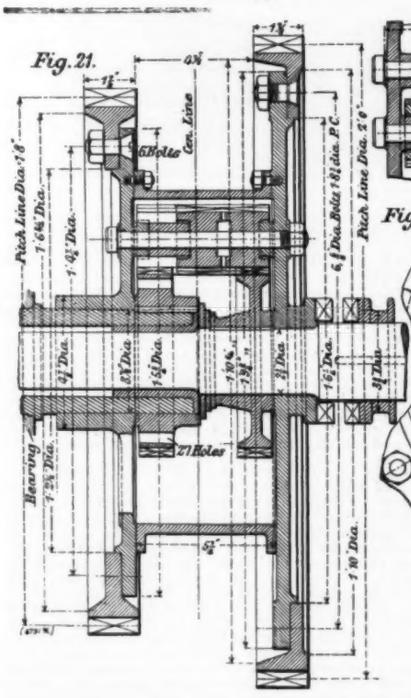
CONSTRUCTED BY THE OMNITRACTOR SYNDICATE, LIMITED, LONDON.

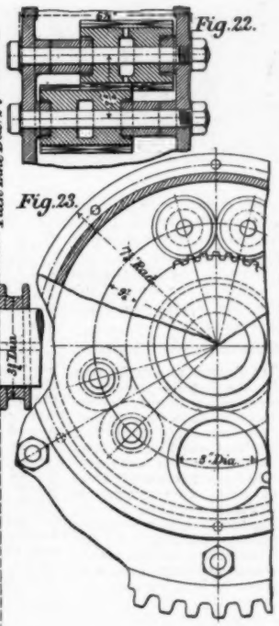


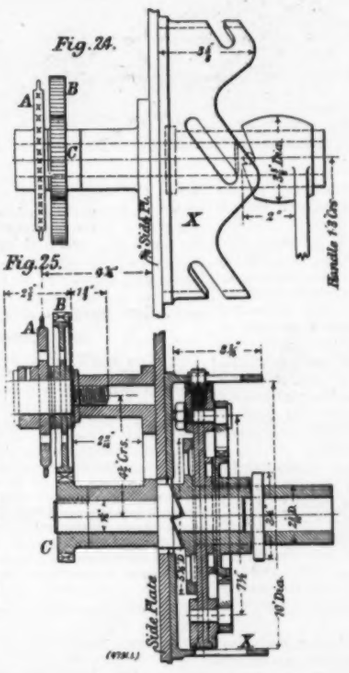


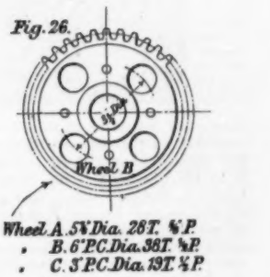


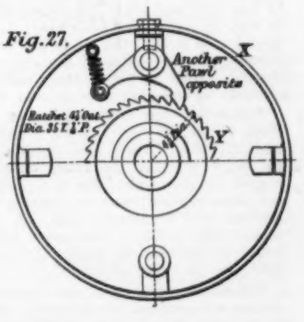












stated. Two speeds, viz., 2½ and 4½ miles per hour, are provided in the forward gear and one in reverse. Independent levers are fitted for operating the changes in direction and the changes in speed, and an interlocking device prevents either lever from being improperly operated.

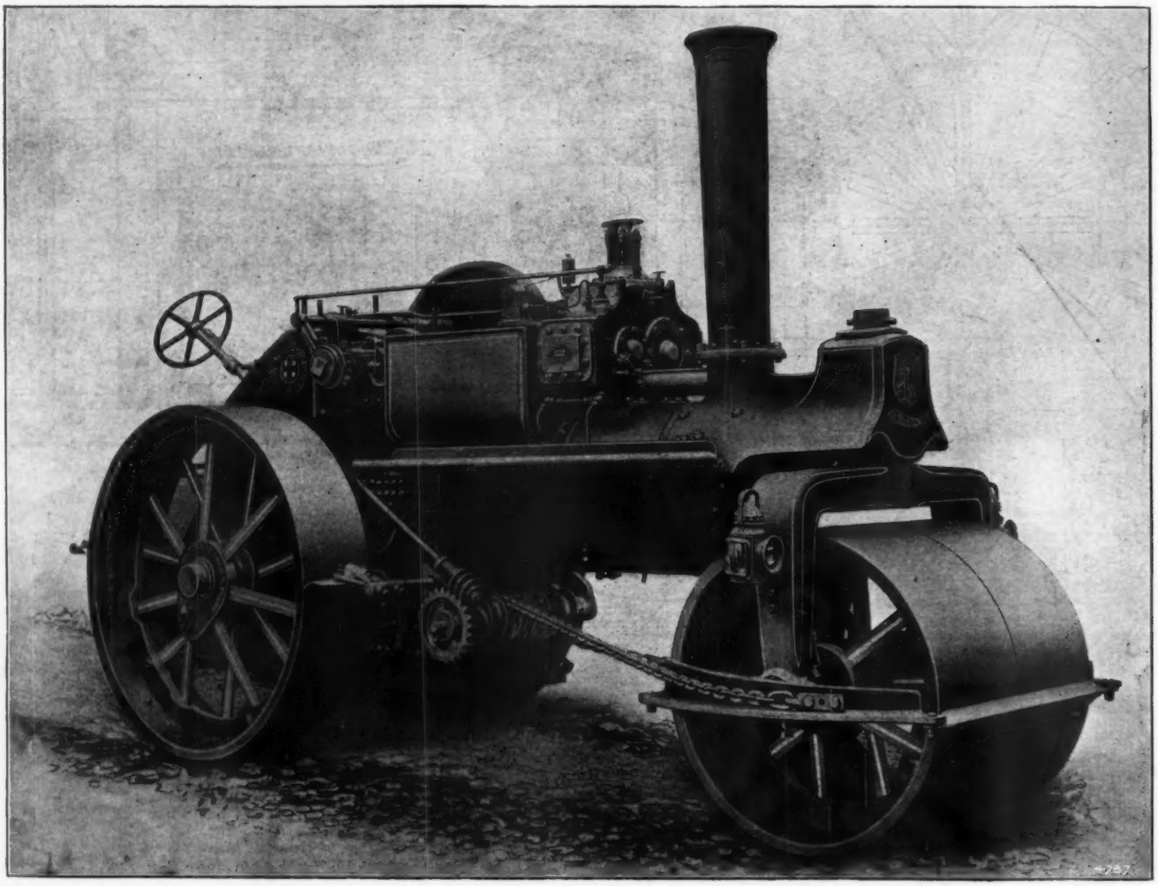
Two brakes are fitted, one for ordinary use and the other for emergencies. The latter, which is applied direct to the drivers, is capable of holding the tractor on the steepest hill. The engine is of a simple design, but special attention has been paid to questions of accessibility. The crank-chamber doors are large enough to enable the pistons to be withdrawn without dismounting the cylinders. The magneto, oil pumps for the forced lubrication, and the starting gear are all mounted on the engine casing. The cooling water is circulated by means of the centrifugal pump D, Fig. 4. It draws its supply from the bottom of the fan-cooled radiator, C, Fig. 4, but before entering this radiator the water has already passed through the induced-draught cooler E, Fig. 3. The cooler is shown in more detail in Figs. 17 to 20, on the present page. It consists of a cylindrical tank fitted with tube-plates at top and bottom. The tubes are 2 in. in diameter, and an up draught is maintained through them by the inductive effect of the engine exhaust, which is discharged through a series of jets below a chimney fitted above the top tube-plate. It is stated that the loss of water inclusive of that injected into the engine when running on paraffin does not exceed one gallon per diem.

In order to fit the engine for running on oil provision is made for heating the air on its way to the engine. This is well shown in Figs. 17 and 18. A by-pass is

COMPOUND STEAM ROAD ROLLER AT THE MANCHESTER AGRICULTURAL SHOW.

CONSTRUCTED BY MESSRS. RUSTON, PROCTOR AND CO., LIMITED, ENGINEERS, LINCOLN.

(*For Description, see Page* 630)



provided on the engine exhaust. With petrol in use the exhaust passes direct through the curved branch P to the silencer Q. On changing over to paraffin, however, the flap valve shown at the entrance end of the curved branch P is moved from the position shown by dotted lines in Fig. 17 to that indicated by the full lines. The exhaust gases have therefore to pass up to the air-heater R which is divided into two parts by a copper casting shown separately in Fig. 19. The exhaust gases, in order to escape, have to flow right and left to the rectangular openings visible in Fig. 19 and thence back again to the centre of the heater. As shown, the air to the paraffin carburettor flows down the centre of the copper casting, and is thereby raised in temperature sufficiently to ensure effective carburisation even in cold weather.

Details of the differential gear are presented in Figs. 21 to 23. As already stated, spur-gearing is used exclusively, three pairs of pinions being provided to couple together the main wheels. Each pair is geared together, and of the two constituents of a pair, one transmits the drive to one side of the differential, and the other to the other side. A dog clutch, shown to the right in Fig. 21, serves to lock the differential when desired, and is thrown in or out of gear by a lever provided on the foot-plate.

The starting gear used is of a special type, embodying an arrangement for preventing injury to the driver in case of a back-fire. It is made in various patterns and one form is shown in detail in Figs. 24 to 27, page 619. As will be seen from Figs. 24 and 25, the starting handle does not operate the shaft direct, but through the intermediary of a sleeve, which is capable of driving the shaft by the claw coupling shown in Fig. 25. If the engine starts properly, the handle disengages itself in the usual way; but if a back-fire occurs, disengagement again takes place by the separation of the claw coupling already mentioned. This is effected as follows: A ratchet wheel Y is mounted on the aforementioned sleeve and connected by pawls with a star frame, the outer ends of which engage with the slots shown in the drum X, which is bolted to the tractor side plate. If the engine starts in the proper direction, the pawls slip, and nothing happens further. If, however, a back-fire occurs, the pawls carry round the star frame with them, and as the ends of the arms of this star rest in the helical slots, the sleeves are forced back, disengaging the claw coupling.

DEMAND FOR PRODUCER-GAS PLANTS IN THE UNITED STATES.—We read in the *Iron Age* that the demand for producer gas plants has become heavy in parts of the Central West in which manufacturers have been depending largely upon natural gas for fuel. This is due to a considerable extent to the fact that one leading distributor of natural gas has given notice to its larger consumers that the supply of natural gas for manufacturing purposes will be cut off in the near future to conserve the supply for domestic uses. Particularly heavy is the demand for the glass industry, which is now installing producer gas equipment to replace natural gas. In this industry cold producer gas is being used for the various melting and annealing operations formerly done with natural gas, hot producer gas, and oil fuel.

THE MOUTIERS GRANGES (SWITZERLAND) RAILWAY TUNNEL.—We read in *L'Ingegneria Ferroviaria* that the new railway tunnel from Moutiers to Granges, in the Swiss Jura, has been for some months past available for traffic. The tunnelling work was commenced in November, 1911; the two headings met on October 27, 1914, at a distance of 4,350 metres from the north entrance, and 4,215 metres from the south entrance. The work of side excavation and the building of the masonry lining were completed on July 24, 1915. The new railway and tunnel establish direct communication between Delle, on the French frontier, and Berne, and form an important means of access to the Lotschberg, and thence to the Simplon. The tunnel, as will be seen from the above figures, is 8,565 metres (5.3 miles) in total length and its highest level is at 543 metres (1,782 ft.) above sea level at a point approximately in the middle of the tunnel length.

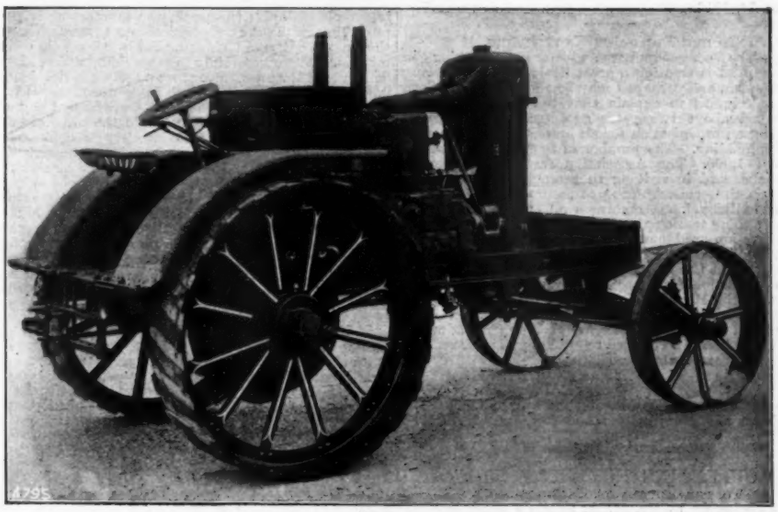
PROGRESS AT THE BROKEN HILL STEEL PLANT.—The Broken Hill Proprietary Company's plant at Newcastle, New South Wales, in the four weeks ended February 9 made 9,890 tons of pig-iron and 7,967 tons of steel ingots, says the *Iron Age*, whilst the blowing mill handled 7,118 tons of ingots, producing billets for shell steel and rails. The rail mill, which has rolled large quantities of shell steel bars, rolled 5,823 tons of rails. The coke output in the same period was 9,200 tons, which was used in the blast-furnaces and 87,206 gallons of tar was produced and sold. Construction work on four new open-hearth furnaces is proceeding, the three in operation being unable to take the pig-iron output of the six blast-furnaces. For the six months ended November 30, 1915, 37,311 tons of steel ingots were poured and 26,573 tons of commercial steel rolled.

GOLD AND TUNGSTEN ORES IN MALAYA.—From the annual report of Mr. W. Eyre Kenny, Senior Warden of Mines, it appears that the quantity of gold placed on the market from the Federated Malay States in 1915 amounted to 18,641 oz., against 14,272 oz. in 1914 and 14,975 oz. in 1913. The approximate value in 1915 was 72,234*l.*, against 55,304*l.* in 1914 and 58,029*l.* in 1913. The total amount of gold saved at the Raub Mine, in Pahang, was 16,103 oz. from the treatment of 127,295 tons, as compared with 13,159 oz. and tonnage of 99,473 in 1914. The total export of tungsten ores from the Federated Malay States was 291 tons, made up of 234 tons of wolfram and 57 tons of scheelite. The corresponding figures in 1914 were: wolfram, 233 tons; scheelite, 29 tons. Tungsten ores aggregating about 405 tons were imported from other countries and re-exported after treatment, and are not included in the above-quoted figures. Mr. Kenny remarks that it is not generally realised that tungsten ores do not occur in the Federated Malay States in defined deposits, and that by far the greater bulk is found in small quantities, irregularly intermixed with tin ore and valueless matter. These facts render it impossible to obtain any large increase in output. Every effort has been made to stimulate production. Export duty has been suspended, special terms have been given to prospectors and also as regards mining rights, though the high price that ruled, would under different natural conditions, have been sufficient to augment production.

20-HORSE-POWER MOTOR-TRACTOR AT THE MANCHESTER SHOW.

CONSTRUCTED BY MESSRS. SAUNDERSON AND MILLS, LIMITED, ENGINEERS, BEDFORD.

(*For Description, see Page* 630.)



MESSRS. YARROW'S WORKS IN BRITISH COLUMBIA.

We give on page 624 illustrations showing the scope and extent of work undertaken at the establishment at Esquimalt, British Columbia, of Messrs. Yarrows, Limited. Two or three years ago, when Mr. (now Sir) Alfred Yarrow visited Canada, he recognised the great possibilities of a shipbuilding, and particularly a ship-repairing, establishment on the Pacific Coast of the Dominion, and the authorities there urged upon him their desires that he should found such an enterprise in view of his great reputation and of the advantages which would accrue. Sir Alfred Yarrow entered upon the project and secured a small existing establishment as a nucleus for the larger enterprise to come when the war brings back commerce to its normal state. The workmen are enlisted from the local population, but these have been supplemented by others who have had their training in Messrs. Yarrow's works in this country. Sir Alfred's son, Mr. Norman Yarrow, is responsible for the management and control of the yard. He is admirably fitted for this. He was educated at the University College School, London. He served part of his time with Messrs. Napier, builders of internal-combustion engines for propelling motor-cars and motor vessels. He then served the rest of his time with Messrs. W. H. Allen and Sons, Bedford. After that he took a trip throughout the manufacturing districts in this country and the United States, so as to get acquainted, as far as possible, with the methods of work and of design in different manufacturing centres.

Fig. 1 is a map showing the location of the works, which are situated west of the City of Victoria, and on the south side of Vancouver Island, so that they are contiguous to the channel through which vessels pass from the Pacific Ocean to the city of Vancouver, in British Columbia, and Seattle and Tacoma, in the United States. Ships therefore will find an immediate and useful refuge where they can be overhauled and repaired. At Lang Cove, which is to the immediate north of the works, the Dominion Government have voted the means for the construction of a graving dock with a length of 1,000 ft., and otherwise suitable for the docking of the largest of ocean liners and warships, and in this way it may be possible to get assistance from the Yarrow Works for the overhaul of the largest of vessels.

The plan of the works is reproduced in Fig. 2. It will be seen that for the present there is only one shipbuilding slip, but when extensions are justified it will be possible to recover from the foreshore sufficient land for the building up of other berths. At the present time the firm have in course of construction on the berth a shallow-draught stern-wheel steamer for one of the Indian rivers. The principal item of equipment in connection with repairing work is a cradle, or what is called in Canada a marine railway, for the accommodation of vessels up to 312 ft. in length, 55 ft. beam, and 3,000 tons gross measurement. There is also a wharf, considerably over 500 ft. in length, on both sides of which it is possible to accommodate vessels for overhaul and repair. The various departments, including foundry, blacksmith's shop, pattern shop, machine shop, saw-mill and joiner's shop, and other accessories, are, it need scarcely be stated, equipped according to the dictation of the experience gained in the British works, so that little need be said regarding these.

The perspective view given on Fig. 3 shows a picturesque aspect of the establishment, and suggests the extent of the overhaul work in progress. There are five vessels shown: the largest, the Union Steamship Company's s.s. Camosun, is berthed in the cradle, and it will be observed that the repairs to the bottom of this vessel are very extensive, the ship having grounded on Digby Island. On the southern side of the wharf there is seen the American barquentine Hawaii, and the Canadian Pacific Railway steamer Princess Alice, whilst on the northern side of the wharf can be distinguished the funnels of the cable steamer Restorer, the boilers of which are being equipped for the burning of oil fuel instead of coal. Beyond the Restorer is the American steamer Mariposa, which had been ashore in Lama Passage, and was floated out by the British Columbia Salvage Company. The view clearly shows the extent to which ship-repairing work can be undertaken. It may be added that Messrs. Yarrow have at Esquimalt an extensive amount of work in progress for war operations, including shells and other munitions.

AMERICAN IRON ORE.—The output of iron ore in the United States last year was 55,526,490 tons, as compared with 41,439,761 tons in 1914. The shipments of 1915 (55,493,100 tons, valued at 101,288,984 dols.) were a little less than the quantity mined. The increase in quantity of the ore shipped last year was 40 per cent. The average value per ton in 1915 was 1.83 dols., as compared with 1.81 dols. in 1914.

LEEDS.—The expenditure made on capital account by the Leeds City Council to the close of March, 1915, was 18,931,055*l.*, of which 9,777,651*l.* was devoted to remunerative works and 9,153,404*l.* to works yielding no pecuniary return. The remunerative works were the following:—Water works, 4,056,404*l.*; gas works, 1,976,724*l.*; tramways, 1,678,844*l.*; electric lighting, 1,347,941*l.*; markets, 488,715*l.*; baths, 115,201*l.*; cemeteries, 103,249*l.*; allotments, 9,793*l.*; and Cross Gates water supply, 780*l.* The principal unremunerative works were:—Street improvements, highways, bridges, and tolls, 2,973,725*l.*; schools, training college and offices, 1,668,350*l.*; drainage, sewage works, &c., 1,880,098*l.*; unhealthy areas, 814,410*l.*; parks and recreation grounds, 561,777*l.*; hospitals, 452,949*l.*; corporation buildings, 302,413*l.*; cleansing depôts, 172,339; and police stations and fire brigade, 126,187*l.* A redemption fund has been formed and 382,069*l.* was paid into this fund in 1915–16. The amount of the redemption fund applied to the repayment of debt during the year was 535,765*l.*, and the aggregate redemption accumulations to the close of March, 1915, were 6,004,477*l.* The nominal amount of debt discharged to the close of March, 1915, was 5,434,216*l.*

NOTES FROM THE UNITED STATES.

PHILADELPHIA, May 14.

THE American steel market has quieted down, though mills have sufficient business to last them practically to the end of the year. Domestic consumers are pursuing the policy, heretofore indicated, of postponing the placing of orders for still later delivery. They recognise that with increasing producing capacity, and other war possibilities, prices may decline before orders in hand are filled; they also recognise that it would not be good business to make contracts now which could not be executed until next year. Orders for export of unknown volume are being placed, and there is still inquiry for some 2,000,000 tons of shell steel, which has been on the market for some time. Some foreign business is also awaiting lower quotation. Pig-iron has had another quiet week; it may decline a little, but not very much, because much new steel-making capacity is coming in which will absorb a great deal of pig-iron making; in what is known as the eastern district of which this city is the centre, the enlargement of capacity in progress will absorb an additional 30,000 to 40,000 tons of pig per month; the output of the mills is somewhat restricted by a deficient labour supply, for which there is no remedy in sight; some consumers try to buy more material than they actually need, but their requirements are severely scrutinised and only the actual wants are supplied. Negotiations are still pending for large quantities of barbed wire for most of the warring nations; there is also a good deal of inquiry for pig-iron for export. The enormous railroad traffic throughout the country will continue to drive the railroad managers into considerable expenditures, especially for locomotives and rolling-stock. The greatest urgency is still maintained for steel plate and top prices continue. The present spirit of conservatism, if it is proper to regard it as such, may continue for some weeks. The overcrowded condition of the mills make it a matter of indifference whether consumers buy or not.

FEMALE LABOUR.—With a view to enabling employers and others interested in the question of substitution of female for male labour to obtain information as to the developments which are taking place in this connection, an Information Bureau has been established at the Employment Department of the Board of Trade for the collection of particulars as to the occupations and processes in which women are replacing men in different parts of the country. Inquiries on this subject addressed to the Information Bureau, Board of Trade, Victoria and Albert Museum, South Kensington, will receive prompt attention.

DIESEL ENGINE USERS' ASSOCIATION.—At the June meeting of the Diesel Engine Users' Association, held at the Institution of Electrical Engineers, a motion by Mr. H. Leslie Dixon (Leatherhead), seconded by Mr. C. O. Milton (Maidenhead), that the Association should support the application of the Suffolk Electricity Supply Company, Limited, to the Board of Trade for the avoiding or suspension during the war of the German patent in regard to "Improvements in Internal-Combustion Engines," to enable tar oils to be used as fuel, was discussed and carried. An interesting paper was also read by the president, Mr. Geoffrey Porter, on "Oil Engines and Steam Engines in Combination," in which he discussed the problems met with in extending a comparatively inefficient steam-driven generating station of about 1,500 kw. capacity, of which there are large numbers in various parts of the country. He dealt with the subject from the point of view of capital costs and working costs and produced tables showing comparisons of actual results obtained by the introduction of Diesel engine plant at various works. He referred to troubles in the working of Diesel engines, but stated that in his own experience he could not desire better or more consistently reliable working than he had obtained. All the examples of generating stations in which Diesel engine plant had been put down as an extension to the steam plant showed a remarkable diminution in working costs.

AMERICAN MACHINERY EXPORTS—The exports of machinery from the United States for the ten months ended with April 30 this year showed an immense expansion, being valued at 140,150,965 dols., as compared with 73,382,651 dols. in the corresponding period of 1914–15. This vast increase was attributable to the diversion of business from Europe to America occasioned by the war. The value of elevator machinery despatched rose from 685,771 dols. in 1914–15 to 1,245,999 dols. in 1915–16; that of gasoline engines, from 3,538,966 dols. to 8,264,973 dols.; that of steam engines, from 2,156,838 dols. to 12,765,079 dols.; that of other engines, from 658,174 dols. to 2,198,116 dols.; that of parts of engines, from 2,207,138 dols. to 5,529,653 dols.; that of metal-working machinery, from 20,664,839 dols. to 42,913,241 dols.; that of milling machinery, from 1,000,376 dols. to 2,048,292 dols.; that of mining machinery, from 3,570,470 dols. to 5,247,367 dols.; that of paper-mill machinery, from 607,011 dols. to 764,001 dols.; that of printing presses, from 1,152,179 dols. to 1,241,019 dols.; that of pumps and pumping machinery, from 2,008,784 dols. to 3,612,643 dols.; that of sugar-mill machinery, from 1,784,194 dols to 5,451,814 dols.; and that of type-writing machines, from 3,982,913 dols. to 7,021,721 dols. The value of the sewing machines exported declined in the past ten months to 4,461,271 dols., as compared with 5,089,533 dols. The increase generally noted in American machinery exports is rendered all the more remarkable by the fact that shipments to some quarters were attended with unusual difficulty.

"ERRORS IN STEAM TABLES."

TO THE EDITOR OF ENGINEERING.

SIR,—The critique on this subject which appeared in your issue for the 9th inst. is of no practical value, inasmuch as it is based solely on the totally wrong assumption that steam is a perfect gas, for which $pv = Rt$. The work of an adiabatic change is not $H_1 - H_2$ but $E_1 - E_2$ or $H_1 - H_2 - \frac{144}{J}(p_1 v_1 - p_2 v_2)$, and the last term does not vanish for adiabatic changes, even for a perfect gas, but has a very appreciable value.

The adiabatic expansion curve $pv^n =$ const. also holds only for perfect gases, and must not be used for detailed scientific criticism of steam work; certainly it is near enough for many practical purposes, but really n is not by any means a constant for such a vapour as steam. Even for such gases as hydrogen, nitrogen, &c., $\frac{p\,v}{t}$ is not constant, and extensive tables of the variations are given in the physico-chemical books, such as the "Landolt-Börnstein Tabellen," whilst for steam the variations are very great.

Fine guarantees of performance are not given from theoretical calculations, but from critical comparisons of previous test results of similar machinery: the reputable firm who will guarantee the performance of an untried machine from theoretical considerations only does not exist.

I would recommend Marks and Davis's Steam Tables, as being one where a large section is given to a critical discussion of the sources and methods used for the compilation of the tables.

Yours, &c.,
P. H. PARR.

4, Princes-avenue, Gt. Crosby, Lancs.
June 20, 1916.

[Our correspondent has evidently not studied our article, or he would have seen that, as is customary amongst steam-turbine makers, the work done by adiabatic expansion through a nozzle, for example, is tacitly assumed to include the work done before "cut-off." In fact, it is the work done after "cut-off" which is of "no practical importance" in steam practice.

The statement that we assumed that the steam acted as a perfect gas is entirely without foundation. All we did in our article was to compare the work done in the Rankine cycle when estimated thermodynamically and by the indicator diagram. The two values should agree, but in the case of the tables criticised they do not. As stated in Marks and Davis (page 83) $H_1 - H_2$ does measure the work done in the Rankine cycle. Our correspondent's expression gives merely the work done after "cut-off," but in that case the comparison should be with $\int p\,d\,V$ (corrected, of course, for the back pressure), instead of with $\int V\,d\,p$. If this be done the same discrepancy will appear.—ED. E.]

THE AMORPHOUS CONDITION OF IRON.

TO THE EDITOR OF ENGINEERING.

SIR,—At the last meeting of the Iron and Steel Institute, held early in May, when referring to the amorphous theory, I find that I quite inadvertently misquoted a remark of Professor Howe. I stated:

"Professor Howe had said that this cement and amorphous theory was one of those precious theories which must for ever remain outside the possibility of demonstration."

I had not the original statement before me. Will you, therefore, kindly allow me to quote the remark as it originally appeared in Howe's new book on "The Metallography of Steel," page 386, which is as follows:

"*Present position of the Amorphous Theory.*

"This brilliant theory is extremely useful in explaining a great mass of extraordinary and hitherto unexplained phenomena. The doubts which remain to-day, so soon after its enunciation, as to its competence to explain the intricate phenomena discussed in the last three sections, are indeed such as might be expected. They may lead us to class it rather among the precious working theories than among those firmly established."

Needless to say, I quite agree with Professor Howe, for I was one of the first, together with the late Monsieur F. Osmond, to welcome the amorphous theory as enunciated by Dr. Beilby. I wish to express my sincere apology to Professor Howe for my misquotation.

Yours faithfully,
J. E. STEAD.

Laboratory and Assay Office, 11, Queen's-terrace,
Middlesbrough, June 26, 1916.

DRAUGHTSMEN.

TO THE EDITOR OF ENGINEERING.

SIR,—I am a draughtsman, and when the war began my wages were *reduced* nearly 20 per cent., while at the same time my nominal working hours were *increased* more than 12 per cent. and my actual hours much more than this.

The men in the shop, many of them unskilled, are paid for every hour which they work. They are paid time-and-a-half and double time for overtime, for night work, and for Sunday work. They have received several large increases of pay since the war began, and they receive a war bonus. In fact, in many cases ordinary workmen's wages have been doubled, trebled, and quadrupled, since the war began. *And all because of their trade unions.*

Personally, I have never received one penny, either for overtime, or for night work, or for Sunday work, but, as before stated, have had my wages (salary I mean) *reduced* and hours *increased*. *And all because I belong to no trade union.*

It looks as though the trade unions have got the Government by the back of the neck, while the employers have got a similar grip of the staff.

Yours, &c.,
June 24, 1916. "STAFFED."

TO THE EDITOR OF ENGINEERING.

SIR,—The correspondence which is appearing in ENGINEERING is creating a great deal of interest among draughtsmen, and perhaps I may be allowed the privilege of your columns to explain that this Association was established about two years ago, for the purpose of providing an organisation for all branches of engineering and shipbuilding. The number of members on the roll is about 1,000. The Association respects commercial aspirations, and in striving to promulgate the general welfare is thus endeavouring to secure greater freedom for the individual. It embraces all shades of political opinion; there are no paid agitators, and all offices under its jurisdiction are honorary. The General Council aims at having a voice in all matters of importance affecting the status and the personal rights of draughtsmen, and in this connection, an important correspondence is taking place with the Ministry of Munitions with regard to the disadvantageous position in which draughtsmen have been placed under the Munitions of War (Amendment) Act, 1916. I shall be pleased to send any of your readers full particulars of the Association.

Yours faithfully,
L. BLAIR, Secretary.

The Association of Engineering and Shipbuilding Draughtsmen, 94, Hope-street, Glasgow, June 26, 1916.

"OIL-ENGINE NOMENCLATURE."

TO THE EDITOR OF ENGINEERING.

SIR,—Referring to Mr. H. A. Stuart's letter in your issue of June 23, and the statement "It was not until I conceived the idea to change the cycle and compress pure air only, keeping out the oil fuel until it was wanted, that I could control automatic ignition under all compression pressures (Patent No. 7146, May 8, 1890)," it is interesting to refer to Dr. Dugald Clerk's Cantor Lectures delivered in 1905, wherein he states:—

"It has often occurred to inventors to avoid all back ignition and other ordinary gas engine troubles by compressing air alone, and adding the inflammable charge just at the moment of completed compression. If this be done, there can of course be no pre-ignition. In 1887 I had an engine built on this principle. This engine used ordinary coal gas, air alone was compressed in the cylinder, the gas was compressed separately by a side pump, forced into the engine cylinder through a series of gas jets and ignited exactly as it entered. This engine worked very well, but the mean pressures obtained were too low."

What Mr. Stuart did in 1890 appears, therefore, to have been to apply to the oil engine what had previously been done in connection with the gas engine.

Yours faithfully,
V. A. B. HUGHES.

25, Market-street (Corner of Corporation-street),
Manchester, June 28, 1916.

LESSONS FROM THE LOSS OF THE "HAMPSHIRE."

TO THE EDITOR OF ENGINEERING.

SIR,—Your correspondent, Mr. R. D. Roberts, must have been writing his letter on "The Lessons of the Hampshire" about the time I attended the Board of Invention and Research, to show a little idea of a pulley system, intended to obviate twisting.

But the Naval Officer refused even to look at it, as useless in his opinion for any purpose afloat, even down in the engine room; and nothing of the sort would ever be seen on deck again, I was assured, where the wire rope hawser, actuated mechanically by steam or electricity, was the only method in use. Excellent as a man-saving device at peace in harbour, and at sea a boat is never lowered except to pick up a man overboard.

So the recommendations of the Advisory Committee of the Board of Trade, on Safety of Life at Sea, have not reached the naval officer of the Invention and Research Board, or else he is waiting for some more Hampshire disasters before taking action.

Yours sincerely,
G. GREENHILL.

Staple Inn, June 27, 1916.

RECORD PRODUCTION AT SOUTH BETHLEHEM.—The following figures of the May output of the South Bethlehem plant of the Bethlehem Steel Company are given in *The Iron Age*: Blast furnaces, total production, 80,171 tons; furnace A, 17,212 tons; open-hearth furnace No. 3, 14,620 tons. Merchant mills: 22-in. mill No. 2, 8,181 tons; 28-in. structural mill, 8,808 tons.

AMERICAN PIG.—The production of coke and anthracite pig-iron in the United States in the five months ended May 31, this year, were 16,188,865 tons. The corresponding output in the corresponding period of 1915 was 19,719,990 tons; in the corresponding period of 1914, 10,483,932 tons; in the corresponding period of 1913, 13,720,209 tons; and in the corresponding period of 1912, 11,452,062 tons

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig-Iron Market.—The pig-iron market still remains closed indefinitely, and at the end of the week the stock of No. 3 iron in store in Glasgow still remained at 1,000 tons, similar to the previous week.

Scotch Steel Trade.—So far as the steel trade in the West of Scotland is concerned, no new development has taken place during the week, the greatest activity still prevailing, while the proposed efforts towards increasing the heavy output of Government work continue to be mooted. There certainly is no diminution in the demands of Government, rather a daily growing increase, particularly for shell bars. In connection with the representations being made to Government by coal-owners to sanction a further rise in the price of coal of all grades, some considerable anxiety is being felt by local steel makers who are specially large consumers, for, if consent be given to the coalowners' demand, this will mean a substantial addition to the cost of production, and, in consequence, a corresponding increase in the price of all manufactured steel and iron. The high rate of pig-iron and all scrap metal, as well as the scarcity of labour combine to suggest a possible hardening before long. Notwithstanding this, there is no falling-off in the way of orders. Ship plates are now quoted round about 14*l.* 12*s.* 6*d.* per ton; boiler plates, 15*l.* 10*s.* or thereabout; and angles, 14*l.* and upwards.

Malleable-Iron Trade.—The malleable-iron trade continues to be alike brisk and busy, and makers are particularly well supplied with orders for everything they produce, their main causes of complaint being the difficulty they are experiencing in keeping deliveries from falling behind, and the continual lack of good puddlers. Day by day additional Government contracts are being placed. For export "Crown" bars are still quoted 14*l.* 2*s.* 6*d.* per ton, while the home rate is now 14*l.* 12*s.* 6*d.*, less 5 per cent.

Scotch Pig-Iron Trade.—The new developments relating to the trade in Scotch pig-iron in the English markets have not yet been clearly defined, but it is expected that a pronouncement will be made very shortly, and meantime expectancy is rife. If fixed on the lines which have been suggested it is expected that more iron will be available on the market for local consumption or for export trade at a good figure. For this oversea business, licenses, naturally, will be required, but as these are rather grudgingly granted, and often take weeks to be put through, the chances are that the home market will benefit. In the case of hematite, which continues in exceptionally strong demand, the entire output is being taken up locally, owing to the extensive manner in which it is being required in the steel-making works. All over, circumstances point to the fact that Government is desirous of conserving every possible source of supply for the production of war material. So many furnaces have now been turned on to the production of hematite that in consequence there is a distinct scarcity of ordinary foundry iron. Prices keep firm, but over the week no advance has taken place, quotations standing as at last Wednesday.

PERSONAL.—Dr. Henry Marion Howe, Professor of Metallurgy of Columbia University, New York, has just been elected an Honorary Vice-President of the Iron and Steel Institute. The Bessemer Gold Medal of the Institute was awarded to Dr. Howe in 1895 in recognition of his great work in the advancement of metallurgical science and knowledge.—The General Electric Company, Limited, of London, and Witton, Birmingham, &c., advise us that the address of their Cork branch, from whence all orders from the south of Ireland are attended to, has now been altered to No. 76, Grand Parade.

PREPARATION OF ALUMINIUM NITRIDE.—Three years ago Dr. W. Fraenkel described the formation of aluminium nitride in an electric furnace from alumina, carbon and nitrogen. He found that very fine soot from acetylene gave the best yields of nitride, and that the reaction, beginning at about 1400 deg. Cent., became energetic at 1500 deg. Cent. He meant further to study the influence of catalysts and of different kinds of carbon on this reaction, but the war has interfered with this research, and he had not much to add to his first communication when addressing the Bunsen Gesellschaft last winter (*Zeitschrift für Elektrochemie*, March 1, 1916). In conjunction with J. Silbermann, he tried petrol coke, graphite and charcoal, all finely powdered. The coke and graphite proved slow in their action, the charcoal was more efficient than the acetylene soot had been. Ordinary charcoal is never free from alkalis, and this alkali has a decided favourable influence. When the charcoal was especially purified—by being treated with dry chlorine gas at 500 deg. Cent. for nearly an hour, and then washed with hydrochloric acid and water—the yield of nitride was distinctly reduced. The addition of alkali to charcoal had been proposed by Giulini Frères in the French Patent 451,405, and a further comfirmation of the useful effect of alkali is afforded by a note which Professor Askenasy added to the above-mentioned paper. Askenasy experimented with technical products, not especially purified. He took 100 parts of bauxite and 50 parts of coke, to which he added, in some experiments, 38 parts of soda. Without the soda he succeeded in binding 11 per cent. of the nitrogen to nitride at a temperature of about 1536 deg. Cent.; when the soda was present the yield rose to 23 per cent. The reaction with alumina takes place according to the equation $Al_2O_3 + 3C + N_2 = 2AlN + 3CO$.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

South Yorkshire Coal Trade.—The position has not undergone any pronounced change during the week, and the scarcity still obtains. Supplies are coming in exceedingly badly, and the last few days' output has been the worst recorded during the present year. Orders are plentiful, but many collieries are refusing to accept further liabilities in this direction. The outlook in the house coal section is none too satisfactory from the coal merchants' point of view. The demand is quite abnormal for the time of the year, and, as the country trade is exceptionally busy at this time, which immediately precedes the hay harvest, collieries are asked for greater deliveries than they can supply. The consequence is a disappointment all round. In addition, the gas companies are in the market for the purpose of replenishing their stocks before the arrival of the winter season. Best hards are freely sought, and the full output is going away without any effort on the part of the salesman. Cobbles and slacks find an active demand with the prices at the maximum, whilst cokes are firm at recent high rates. The tonnage for shipment is slightly above the weekly average, but the scarcity of freight is delaying many consignments. From 20*s.* to 30*s.* is the price paid by French customers, whilst neutrals offer anything up to 45*s.* f.o.b. if early delivery can be promised. Quotations:—Best branch hand picked, 20*s.* 6*d.* to 21*s.* 6*d.*; Barnsley best Silkstone, 17*s.* 6*d.* to 18*s.* 6*d.*; Derbyshire best brights, 17*s.* 6*d.* to 18*s.* 6*d.* Derbyshire house coal, 16*s.* to 17*s.*; best large nuts, 15*s.* 6*d.* to 16*s.* 6*d.*; small nuts, 15*s.* to 16*s.*; Yorkshire hards, 16*s.* 6*d.* to 17*s.* 6*d.*; Derbyahire hards, 16*s.* to 17*s.*; best slacks, 12*s.* to 13*s.*; seconds, 10*s.* 6*d.* to 11*s.* 6*d.*; and small, 8*s.* to 9*s.* per ton.

Iron and Steel.—One effect of the extraordinary demand for steel on behalf of munitions has been to reduce to a minimum the surplus of basic steel available for "domestic" purposes. Unless orders can be classed either "A" or "B" under the certificate of the Ministry of Munitions manufacturers have scant prospect of getting the necessary raw material. Directly or indirectly the whole of the Sheffield steel works are now engaged in producing for the Government. Heavier deliveries are requested, but the insufficiency of the labour is restricting expansion. It has been recently expressed that the responsible authorities are eminently satisfied with the work performed in Sheffield. There will be a striking new development in the early days of July. A new factory will be opened and will employ fully 6,000 women, or considerably more than the whole of the present total of women so engaged in the city at the present time. The deliveries of iron to the local steel works have just been sufficient to maintain the daily output, but no reserves can be obtained. The market has been very quiet. Hematites continue scarce, and the shortage becomes more acute day by day. Several idle furnaces are being turned to blast, and other steps are being taken in the hope of increasing the production. Makers of all brands of iron are unwilling to sell in view of the consultations that are taking place on the prices tariff. The present arrangement ends this week. Makers expect a rise of 5*s.* on hematites, and a proportionate increase on common irons. An advance is stated to be inevitable, but the extent is not yet the subject of a uniform agreement. Swedish steel shipments are dwindling down rapidly, and the quotations show a marked advance as a consequence. Billets are now from 30*l.* to 34*l.*, whilst wire rods cannot be purchased at less than 45*l.* or 46*l.* Steel alloys are none too plentiful, and values have risen, especially in the case of ferro-chrome, which France supplies. A Government department is devoting attention to the complaints of steel-makers that their output is interfered with by difficulties in securing the silica bricks for building the furnaces, and the composition to line them. Efforts are being made to improve the supplies. High-speed steel manufacture proceeds at tremendous pressure. Orders are far in excess of the resources of the works, but the Government requirements are always met by reason of the priority they exercise over the other classes. Cases are reported where firms have closed their order-books, except in the event of extreme urgency. A factor which limits the output is the shortage of tungsten. Refiners of the wolfram ore cannot obtain sufficient tonnage to produce all the tungsten required. There is great activity in the twist-drill trade. The indents received week by week are nearly 100 per cent. in advance of the total production. A recent concession, whereby cutlery can be exported to foreign and colonial markets without the necessity for an export certificate, has led to a great increase in the volume of cutlery export trade. The latest overseas indents for the general export trade of the city are for steel, springs, saws, knives, files and hardware.

BELGIAN COAL.—The output of coal in Belgium in 1903 was 23,871,000 tons; in 1913 the output had declined to 22,858,000 tons. The production has been practically stationary for the past 20 years. While Belgian coal-mining has thus made little or no progress of late, the output of coal in the United States increased between 1903 and 1913 to the extent of 60 per cent.; that of Great Britain, 23 per cent.; that of Germany, 18 per cent.; and that of France, 15 per cent. As the production of pig-iron from Belgian blast-furnaces was increasing before the war, it was necessary to import more coal from Germany. Of course the war has utterly disorganised Belgian metallurgy, coal-mining, coal-importing, and other industries.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Output of Pig-Iron.—The promised increase of production of pig-iron is likely to be fulfilled at an early date. Preparations are about complete for the re-starting of idle plant, and it is expected that some four or five additional blast furnaces will be put into operation during the month of July. The number of furnaces now blowing on the North-East Coast is 70, of which 28 are making Cleveland pig, 29 are producing hematite, and 13 are manufacturing special kinds of iron.

Cleveland Pig-Iron.—Business in Cleveland pig is on only a moderate scale, largely due to the fact that many makers hesitate to commit themselves far ahead to any great extent. Buyers are much in evidence, and would willingly make contracts to the end of the year, but they experience considerable difficulty in doing so. For home consumption No. 3 has been sold over next quarter at 87*s.* 6*d.* The export quotations are decidedly easier, but foreign business is still very quiet owing to the continued prohibition of shipment to neutral countries, and the difficulty in obtaining permits to deliver even to our Allies. There are persistent rumours that a fixed export maximum of 95*s.* is about to be announced for No. 3. Be that as it may, merchants are quite prepared to sell at 97*s.* 6*d.*, and no doubt purchases could be made at 95*s.* No. 1 is in the neighbourhood of 100*s.* for export, and No. 4 foundry is round about 95*s.*

Stocks of Cleveland Pig-Iron.—For some time past makers have had practically no iron lying at their yards. The quantity held in the public warrant stores here now stands at 29,672 tons, composed of 27,910 tons of No. 3 and 1,762 tons of other qualities of Cleveland iron, deliverable as standard. Since the beginning of the month the stock has been reduced by 3,544 tons, 3,780 tons of No. 3 having been withdrawn, and 236 tons of standard iron having been added.

Hematite Iron.—Very little East Coast hematite iron is purchasable, there being no stocks, and makers being sold well ahead. For home consumption, Nos. 1, 2 and 3 stand at 122*s.* 6*d.*, and that price also rules for shipment to France, but the general export price is 140*s.* and upward. There are export buyers at 140*s.*

Shipments of Pig-Iron.—Official returns of shipments for June are not obtainable at the time of writing, but they will probably show the loadings at the port of Middlesbrough during the month to have been something like 50,000 tons. For the previous month the clearances of pig reached 67,880 tons, and for June last year the shipments were given at 36,806 tons.

Foreign Ore.—The situation in foreign ore is somewhat peculiar. Notwithstanding continued heavy supplies on running contracts coming regularly to hand, and the fact that most consumers are now carrying considerable stocks, values show a very marked upward tendency. The minimum ex-ship Tees price of Rubio of 50 per cent. quality is 36*s.* 6*d.*, and that is for delivery to controlled consumers, for whom the Government still arrange so that the Bilbao-Middlesbrough freight is 17*s.* In the open market the freight is 19*s.*, so that to non-controlled firms the quotation is 38*s.* 6*d.* Imports of foreign ore to the Tees for June are to-night (Wednesday) officially returned at no less than 227,248 tons, and the two days' unloadings to be added will make the total approach 250,000 tons.

Coke.—Coke keeps in good demand and quotations are strong. Average blast-furnace kinds are 28*s.* at the ovens, and up to 30*s.* 6*d.* at the ovens is named for qualities low in phosphorus.

Manufactured Iron and Steel.—The rather numerous ordinary commercial inquiries in the market attract little attention, producers of nearly all kinds of finished iron and steel being occupied on Government work. Prices all round are very firm. The following are among the principal market quotations:—Common iron bars, 13*l.* 15*s.*; best bars, 14*l.* 2*s.* 6*d.*; double best bars, 14*l.* 10*s.*; treble best bars, 14*l.* 17*s.* 6*d.*; iron ship plates, 11*l.* 10*s.*; iron ship angles, 13*l.* 15*s.*; iron ship rivets (¾ diameter), 17*l.* 10*s.*; iron ship rivets (⅝ diameter), 18*l.* 10*s.*; packing iron and steel (parallel), 10*l.*; packing iron and steel (tapered), 12*l.* 5*s.*; steel bars (no test), 14*l.* 10*s.*; steel ship plates, 11*l.* 10*s.*; steel ship angles, 11*l.* 2*s.* 6*d.*; steel ship rivets (¾ diameter), 18*l.* 10*s.*; steel ship rivets (⅝ diameter), 19*l.* 10*s.*; steel sheets (singles), 18*l.* 10*s.*; steel sheets (doubles), 18*l.* 15*s.*; steel strip, 17*l.*; steel hoops, 17*l.* 10*s.*; steel joists, 11*l.* 2*s.* 6*d.*; and heavy sections of steel rails, 11*l.*

NOTES FROM THE SOUTH-WEST.

Cardiff.—In the steam coal trade both buyers and sellers have been disposed to hold their hands in view of the uncertainties of the near future. Coal-owners in most cases are so well booked on Government account that they do not expect to have any surplus coal to offer for some little time; and this being the case, they are not disposed to make concessions. On the other hand, buyers, looking to the short offerings of tonnage, are calculating on increased stocks of coal, especially as the output is improving. Arrangements for coal shipments to France under the limitation of prices and freights scheme are stated to be still unsettled. The best Admiralty large steam coal has been to some extent nominal; secondary descriptions have made 49*s.* to 50*s.*; Monmouthshire black veins, 49*s.* to 50*s.*; ordinary Western Valleys, 49*s.* to 50*s.*; Eastern Valleys, 45*s.* to 47*s.* 6*d.*; best bunker smalls, 29*s.* to 30*s.*; and cargo smalls, 20*s.* to 22*s.* per ton. In bituminous coal best households have made, at the pits, 23*s.* to 24*s.*; No. 3 Rhondda large, 49*s.* to 50*s.*; smalls, 32*s.* to 34*s.* No. 2 Rhondda large, 36*s.* to 38*s.*; and No. 2 smalls, 23*s.* to 25*s.* per ton. The latest quotation for patent fuel has been 50*s.* to 51*s.* per ton. Special foundry coke for export has realised 62*s.* to 65*s.*; good foundry coke, 60*s.* to 62*s* 6*d.*; and furnace coke, 50*s.* to 55*s.* per ton.

Western Trade Matters.—The capital of the Celtic Collieries Company has been divided into 400,000 preference shares of 10*s.* each and 400,000 ordinary shares of 10*s.* each.—Mr. B. Pardoe Thomas invited a large number of friends to join him in an afternoon reception at the harbour office on Monday. Mr. Alderman Mordey, speaking to the toast of "The Harbour Board," looked forward to better times for Newport than had ever before prevailed, especially if all interests pulled together.—At the twenty-first annual meeting of the Cardiff Channel Dry Docks and Pontoon Company, Limited, it was stated that the profits of the past year were a record, amounting to 38,944*l.* for the 12 months, being 4,592*l.* more than in the previous year, although 20,000*l.* had been set apart for an addition to the reserve fund and reserved for the excess profits tax, redemption of debentures, &c.—Lord Rhondda has resigned from the Board of the Ebbw Vale Steel Iron and Coal Company, Limited, and his resignation has been reluctantly accepted.—The development of the iron ore bearing made in Northamptonshire is proceeding; a considerable additional area has been acquired, bringing the total up to about 2,000 acres. In view of large additional commitments, the directors have now before the Treasury an application for authority to issue 600,000*l.* of additional ordinary capital. The total expenditure last year for property acquired and new works was 255,742*l.*—The steel steamer Easingwold, built at West Hartlepool in 1898, of about 5,000 tons deadweight, has been sold to Mr. D. L. Barrett, Cardiff.—Mr. J. Moxon has been unanimously chosen chairman of the Newport Harbour Board. Mr. Moxon, in thanking the Board for his election, said a Bill of the docks company, which would shortly receive the Royal assent, would secure a deep-water entrance to the docks. As regards the Usk, he hoped that something would be done at the proper time to improve the river. At present there were too many wharves out of commission, and he trusted that there would be a conference of landowners and wharf-owners to see if they could come to some common agreement for improvement objects. He wished it to be understood that there was no idea of competing at all with the docks.—The directors of the Prince of Wales Dry Dock Company (Swansea), Limited, recommend a final dividend of 10 per cent. for the past year, free of income tax, carrying forward 8,311*l.*; an allocation of 15,000*l.* is also made to the reserve. The profits for 1916 were 12,818*l.*, after providing for depreciation, excess profits tax, &c.; the corresponding profits for 1915 were 10,374*l.*; for 1914, 9,596*l.*; for 1913, 8,643*l.*, and for 1912, 6,275*l.* The dividend for 1912 was 7½ per cent.; for 1913, 1914 and 1915, 10 per cent., and for 1916, 15 per cent.—The Great Western Colliery Company has announced an interim dividend for 1916 of 10 per cent., payable July 24.—A meeting of the Cardiff and Bristol Channel Shipowners' Association was held at Cardiff on Friday to consider the enormously increased charges imposed on shipowners at British ports by advance demands of various classes of workmen. It was decided to take steps to deal with the question promptly, and it is not improbable that the Board of Trade will be asked to intervene in the matter.

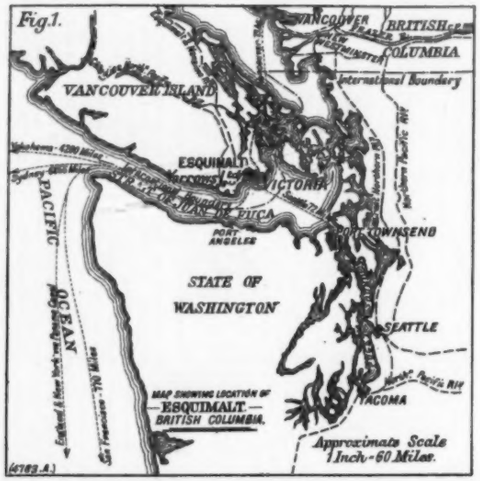
THE COAL-MINING INDUSTRY OF POLAND.—The coal of the Dombrowa Basin is fairly uniform, and belongs to the "lean" class, burning with a long flame. The average heating value amounts to 12,000 B.Th.U. The Dombrowa coal is not suitable for the production of coke or for lighting gas. The more important mines of the district in question are to a great extent controlled by foreign capital, as will appear from the following table, giving particulars of concerns and annual production in the last year before the war:—

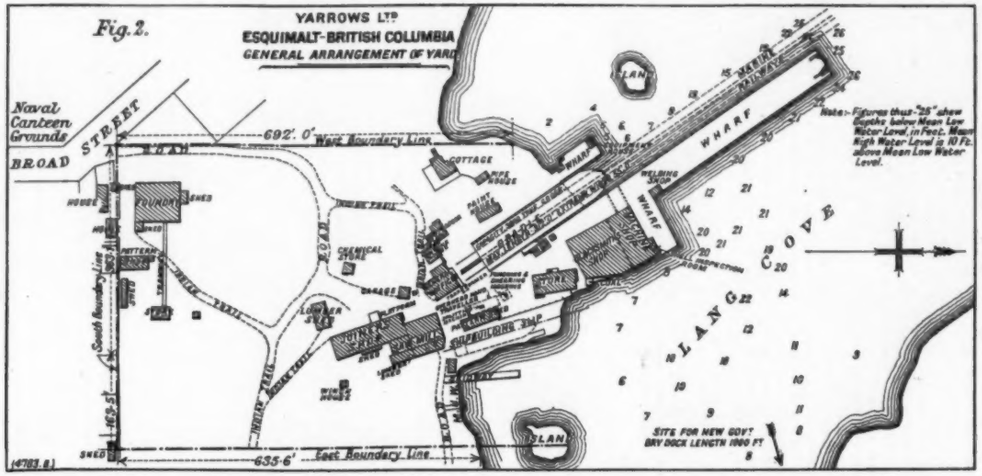
Name.	Nationality.	Capital.	Production.
		Roubles.	Tons.
Sosnowice Coal Mining Co. ...	French	9,750,000	1,472,000
Warsaw Coal Mining Co. ...	Polish ...	3,000,000	876,000
Saturn Mining Co....	German-Russian	5,000,000	853,000
Count Renard	French	7,098,000	704,000
Société Franco-Italienne	French	2,250,000	650,000
Grodziece Coal Co.	German	2,625,000	642,000
Czeiads Coal Co.	French	9,750,000	617,000
The Flora Concern...	Austrian	1,050,000	396,000
French-Russian Rudes Mine ...	French	2,250,000	274,000
The C. G. Schöncomern	German-Russian	?	97,000

In addition to the above there are 14 smaller mines belonging to different owners and with an aggregate production of 240,000 tons. Of the production, 9 per cent. is used by the mining concerns themselves, the bulk is sold within Poland, about 10 per cent. being exported to Russia. Most of the large mines used to belong to the State, and some were under German control, but State interference brought about a withdrawal of German capital, and the new companies were formed principally with French capital. Also the State mines were sold or let to French concerns, so that only two companies remain in German and Austrian possession. Russian and Polish capital is only slightly interested in the Polish coal-mining industry. An aggregate of 22,897 hands are employed, which makes the average production per hand per year 222 tons; this low figure is attributable to the old-fashioned and inadequate plant, &c.

THE SHIPBUILDING AND SHIP-REPAIRING WORKS OF MESSRS. YARROW, LTD., AT ESQUIMALT, BRITISH COLUMBIA.

(*For Description, see Page 621.*)





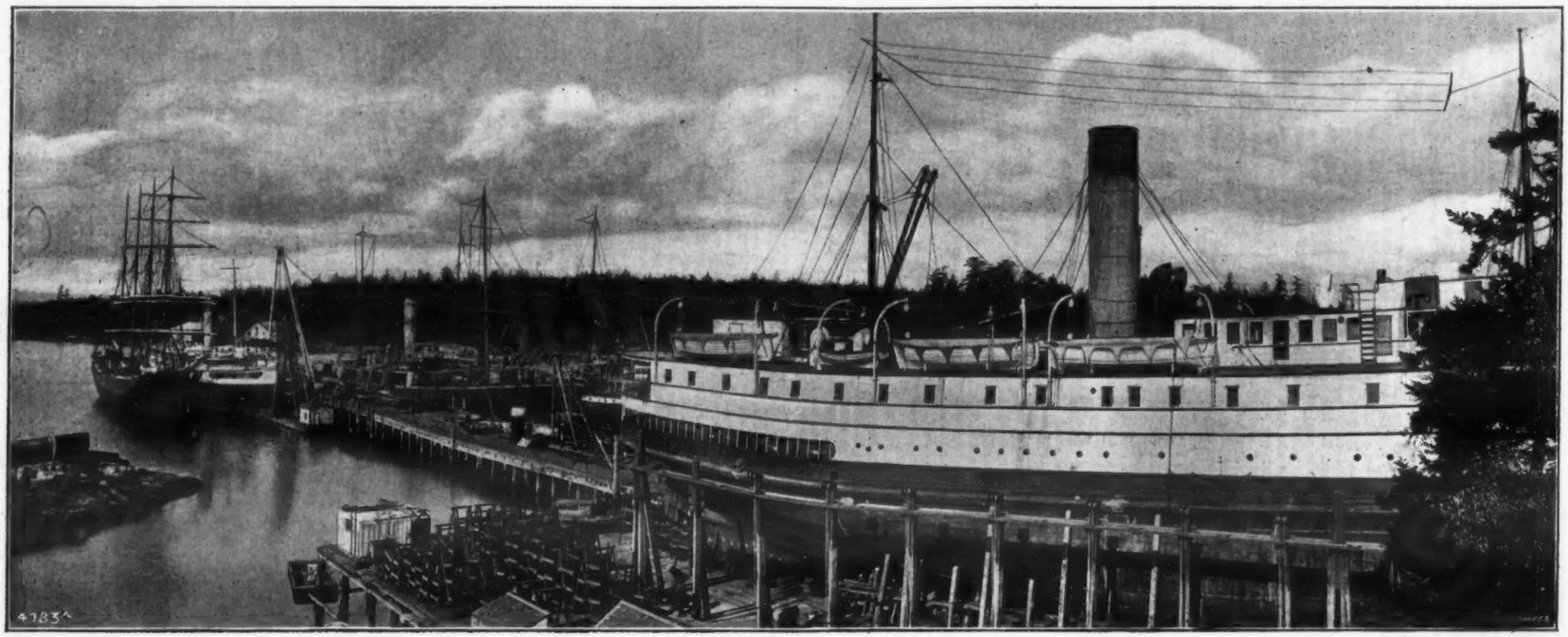


FIG. 3.

THE BRAZILIAN SUBMARINE DEPÔT MOTOR-SHIP "CEARA;" 200-TON CRANES FOR RAISING SUBMARINE BOATS.

CONSTRUCTED BY THE FIAT SAN GIORGIO COMPANY, SPEZIA, ITALY.

(*For Description, see Page 613.*)

Fig. 10. OUTSIDE ELEVATION

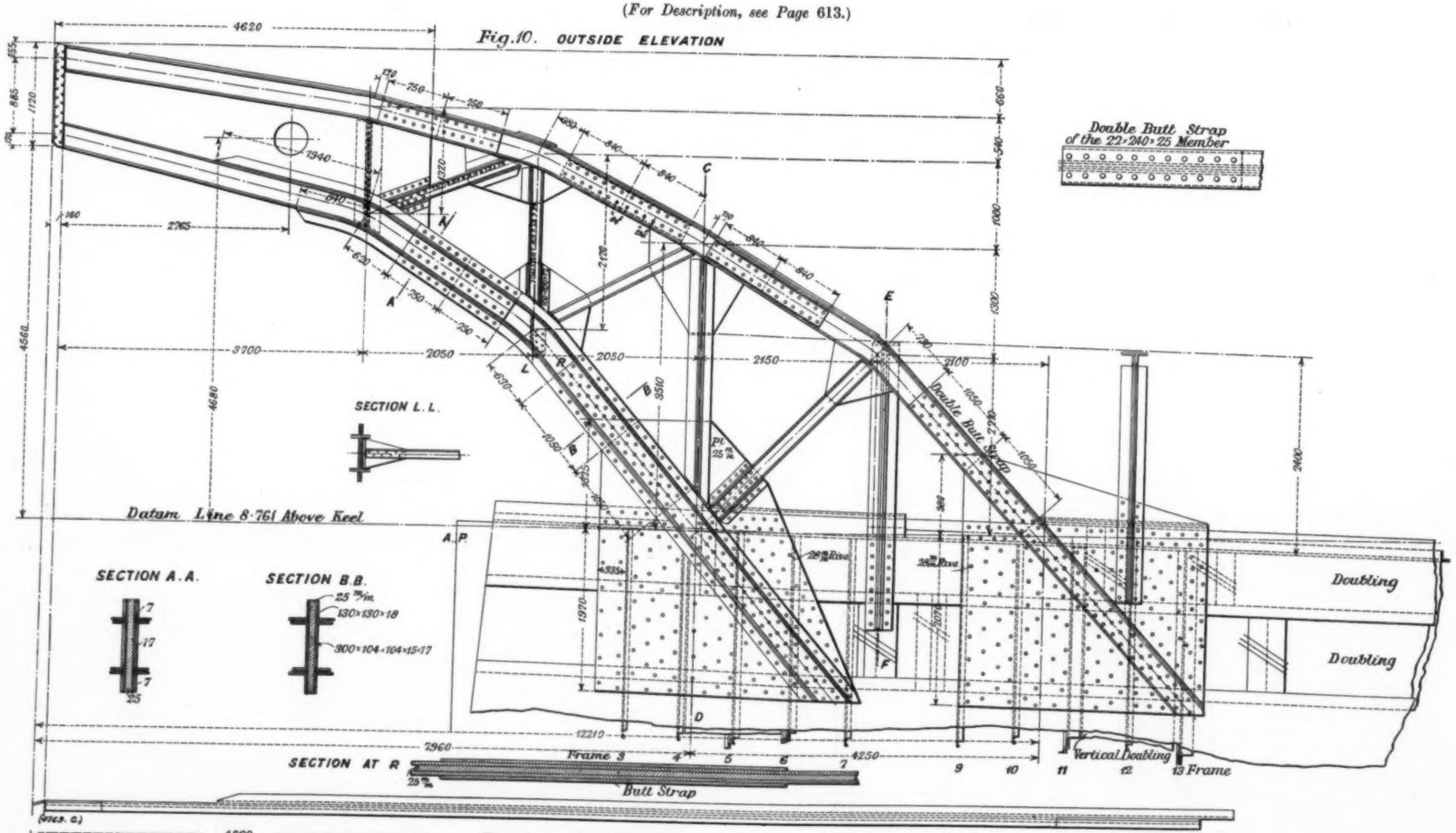
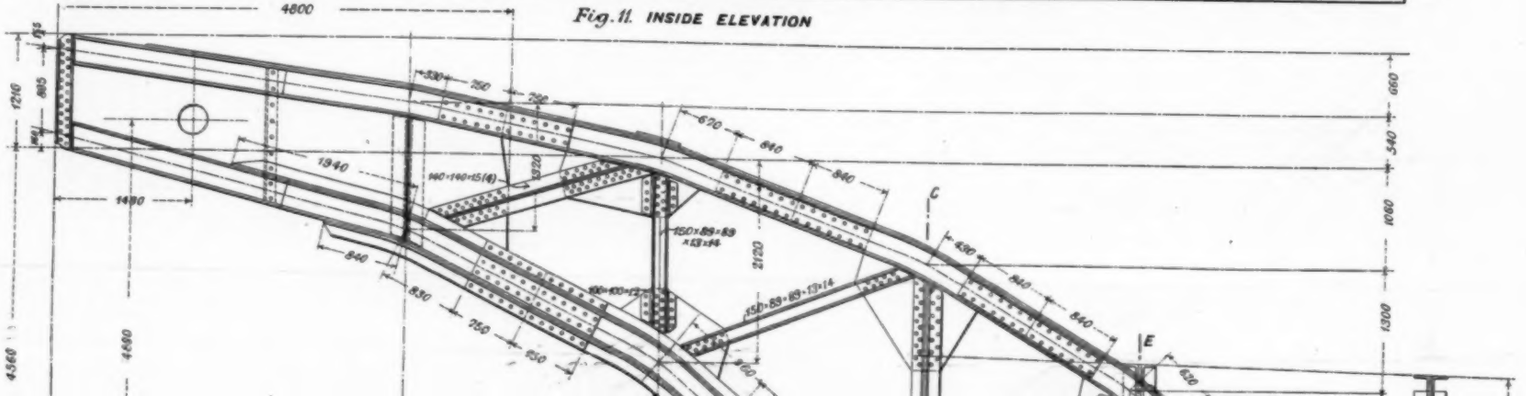


Fig. 11. INSIDE ELEVATION



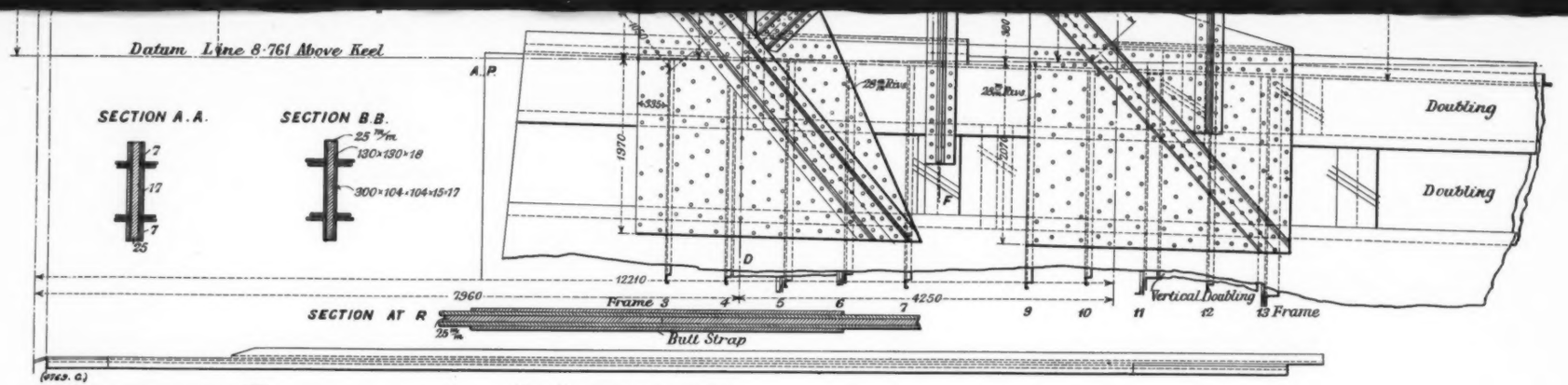
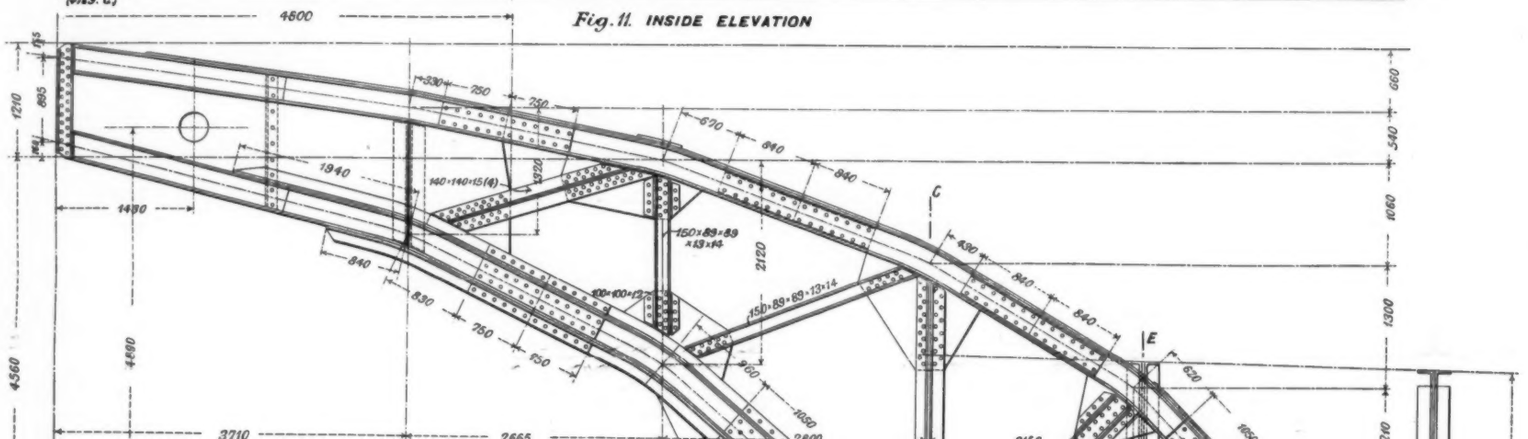
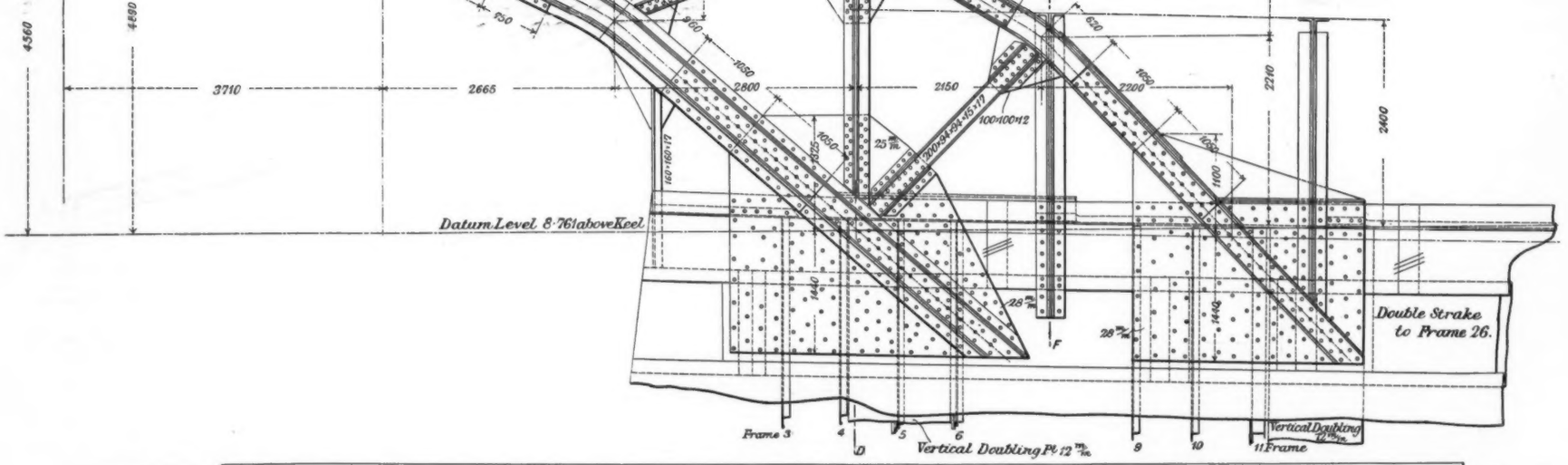
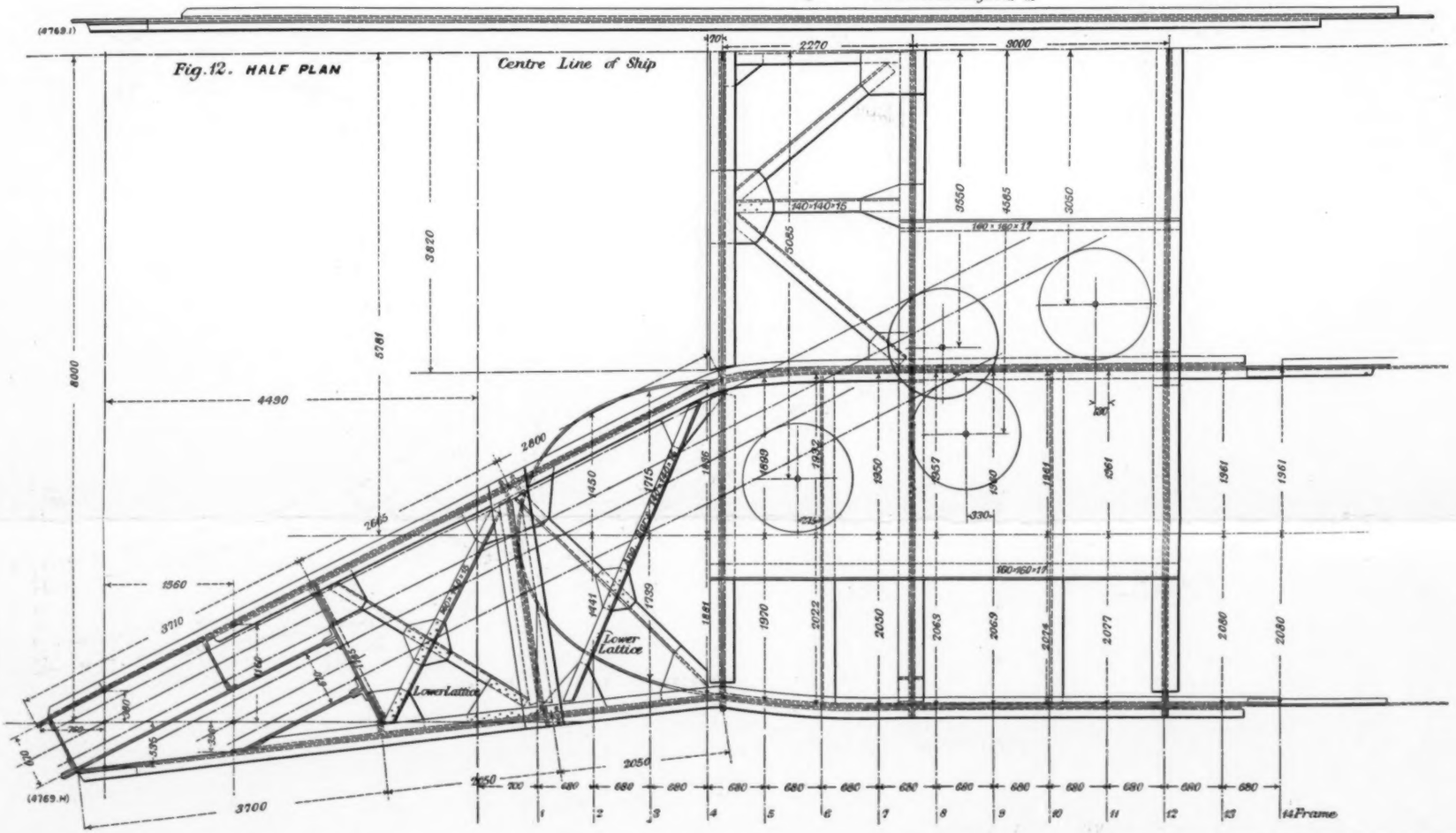


Fig. 11. INSIDE ELEVATION




4360
4690
3710
2665
750
960
1050
2800
2150
620
1050
2200
2210
2400
100×100×12
160×160×17
1100
1440
Datum Level 8·76 above Keel
Double Strake
to Frame 26.
Frame 3
4
5
6
D
Vertical Doubling Pl. 12 m/m
8
9
10
11 Frame
Vertical Doubling


(4769 J)
Fig. 12. HALF PLAN
Centre Line of Ship
2270
3000
3820
5781
6000
4490
2800
3710
1560
2665
140×140×16
160×160×17
3550
4565
3050
3085
1715
1450
1441
1239
1841
1970
2022
2050
2063
2069
2024
2077
2080
1961
1932
1660
1950
1857
1920
330
Lower Lattice
Lower Lattice
2050
(4769 M)
3700
1250
200
680
1
2
3
4
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14 Frame

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Advertisements intended for insertion in the current week's issue must be delivered not later than 5 p.m. on Thursday. In consequence of the necessity for going to press early with a portion of the edition, alterations for standing advertisements should be received not later than 1 p.m. on Tuesday in each week.

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We desire to call the attention of our readers to the fact that the above is our SOLE ADDRESS, and that no connection exists between this Journal and any other publications bearing somewhat similar titles.

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TELEPHONE NUMBERS—3663 and 8596 GERRARD.

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With a Two-Page Plate of the BRAZILIAN SUBMARINE DEPOT MOTOR-SHIP "CEARA;" 200-TON CRANES FOR RAISING SUBMARINE BOATS.

NOTICES OF MEETINGS.

THE PHYSICAL SOCIETY OF LONDON.—Friday, June 30, at 5 p.m., at the Imperial College of Science, Imperial Institute-road, South Kensington, S.W. Agenda:—1. "A Sensitive Magnetometer," by Dr. P. E. Shaw and Mr. C. Hayes, B.Sc. 2. "The Latent Heat of Fusion of a Metal and the Quantum Theory," by Dr. H. S. Allen. 3. "Experiments on the Thermo-Electric Properties of Fused Metals," by Mr. C. R. Darling, A.R.C.S. 4. "Cohesion," Part 2, by Professor H. Chatley, D.Sc.

THE ROYAL SANITARY INSTITUTE.—Friday, July 7, at 2.30 p.m., Visit to Manchester Co-operative Wholesale Society's Works, Crumpsall. At 7 p.m., at the Municipal School of Technology, Manchester, when a discussion will take place on "The Necessity for a National Scheme of Physical Education," to be opened by Major R. Tait Mackenzie, R.A.M.C. (Professor of Physical Education, University of Pennsylvania). The chair will be taken at 7 p.m. by Mr. H. Percy Boulnois, M. Inst. C.E. (Deputy Chairman of the Council of the Institute).

NOTICE TO NON-SUBSCRIBERS.

In view of the restrictions now imposed by the Government on the importation of paper, and of the consequent shortage of supplies, readers who wish to be sure of obtaining "ENGINEERING" each week should place an order for the Journal with a newsagent or bookstall clerk. Owing to the scarcity of paper it will be impossible in future fully to provide for a chance demand for this Journal.

ENGINEERING.

FRIDAY, JUNE 30, 1916.

THE GOVERNMENT AND WAR PROFITS.

THERE can only be universal and complete approval of the action of the Government in taxing war profits, because these cannot be in all cases regarded as rewards of merit or even of excessive energy. They are in many instances the result of the exigencies of the nation. They are earned at the expense of the nation. At the same time it must be accepted that as there are various conditions, there is justification for differential treatment. Moreover, it is important that in exacting the tax on war profits care shall be exercised to ensure that industry, now and in the future, shall not be crippled owing to deficiency in that great essential—working capital. Those responsible for the national exchequer can urge the general argument in favour of higher taxation, that is, the importance of meeting out of revenue as fully as possible the extraordinary expenditure on the war. Thus the proposal, made a year ago, to exact 50 per cent. of excess profits in the first year of the war upon all non-combative or normal work was approved. Even now the proposition to raise this rate to 60 per cent. for the current year is accepted, notwithstanding that the sum deducted for normal income tax increases the proportion of the war profit thus exacted by the Treasury to 85 per cent., leaving only 15 per cent. to the merchant or manufacturer. Where the profit has been earned in ordinary commerce, without any direct association with the immediate prosecution of the war, little objection can be taken to this relative proportion.

The case of controlled establishments is on a different basis. In the great majority of cases of merchants' profits the increased earnings are at the expense of the people. The public have had to pay higher charges, and it should not be forgotten that with the grocer, the butcher, and other like tradesmen, the practice continues of exacting a definite rate of profit upon the turnover. Where, therefore, by reason of higher freights and higher cost of distribution, the wholesale price to the retailer has gone up, higher total profit accrues without any proportionate increase of effort or risk. In such cases there is no interference with the normal practice of the shop or factory. There has been continuity from the past and the probability of continuity in the future. But the great majority of the 4,000 odd establishments now controlled have had to relinquish the practice of the past. They have had to put aside many machine tools used in the past and to instal new, or adapt old, appliances for entirely new manufactures. This dislocation and re-arrangement has demanded great organising ability, and the exercise of ingenuity and other qualities, while the great demand for munitions has involved, for proprietor, staff, and men, more severe physical effort. The prospect for the future, too, is clouded, because, by the dislocation of the peace trade of the respective controlled establishments and its capture by foreign neutral countries, great difficulty has been created in respect of the recapture of the trade and the reorganising of the factory on its pre-war basis. These facts alone justify differential treatment as between munition works and the ordinary peace or commercial establishments in the imposition of a tax or limitation of war profits.

The creation of the new department of the Government for the supply of munitions was a consequence of the recognition of the immense importance of thoroughly equipping the huge army suddenly called into being because of the war. To-day the numbers in the standing army are thirty times those of the peace organisation; but apart from this enormous increase in *personnel*, there had to be met the immense demand for munitions to meet the modern conditions of warfare, so that no comparison is possible in respect of the needs for war munitions now and in peace time. It was consequently recognised that the maximum service must be exacted from the nation's workers, male and female, and it became imperative that such trade-union regulations and restrictions as were imposed in peace time should be discontinued. Such concession by the workers required that there should be limitation to the possibility of excess profits consequent upon any concession made by labour. The employers were as willing to admit the justice of this as the Minister of Munitions and his colleagues, so that no objection whatever was made to the proposed limitation of profits on war munitions. Thus, in the Act establishing the Ministry of Munitions there was embodied not only the conditions enforced upon trade unions and employers, but the decision of the Government and Parliament regarding profits. The Act laid down specifically what profit the employers were to take, the balance going to the Treasury: it did not define the proportion which the State was to have. There can be no question of the splendid work done under the Act. It is true that a fuller measure of compliance with its conditions was possible in some cases and at some periods on the part of the workers, but so far as employers are concerned there has never been the slightest suggestion of anything but the highest patriotism and the fullest determination to use every available means for meeting the requirements of the Navy and the Army.

In view of all the circumstances, there can be nothing but extreme surprise that the Chancellor of the Exchequer should now seek to nullify the agreement made between the Minister of Munitions and the owners of controlled establishments, and embodied in the Ministry of Munitions Act. In the Finance Act for the current year, as already stated, Mr. McKenna seeks power to take for the Treasury 60 per cent. of excess profits in ordinary business, in addition to income tax on the total amount, making in many cases 85 per cent. for the year. This power is to be applied to controlled establishments provided it will bring to the Treasury a greater return than the limitation of profits imposed under the Munitions Act. Practically every unofficial member of the House of Commons, irrespective of their party ties, is, it is said, opposed to this proposal. The number who voted against the Government was a surprise to the Government, and we hope that in the report stage of the Finance Bill a reversion will be made to the agreement made with the controlled firms. Apart altogether from the increased amount of clerical work involved in making two entirely different returns of profit, so that taxes may be imposed to suit the preference of the Treasury, the proposition of the Chancellor of the Exchequer is a breach of faith. His contention is that the limiting conditions in the Ministry of Munitions Act did not free the controlled firms from the universal imposition of taxation. The wording of the Ministry of Munitions Act does not bear this out. Clause 5, under which "the limitation of the profits of the controlled establishment" is imposed, states: "The net profits of the controlled establishment shall be ascertained in accordance with the provisions of this section and rules made thereunder, and the amount of profits divisible under this Act shall be taken to be an amount exceeding by one-fifth the standard amount of profit. The standard amount of profit for any period shall be taken to be the average of the amount of the net profits for the two corresponding periods completed next before the outbreak of war." Then follows the

arrangements for setting up referees or boards for determining any difference of opinion regarding the standard amount of profits and other such questions. It is to be noted that while in some cases the turnover in controlled establishments is 200 to 400 per cent. that in peace times, the addition to profit is only to be 20 per cent., or, if Mr. McKenna has his way, 15 per cent. or less. If the profit thus allowed to controlled establishments was to be subjected to the universal exaction of taxation, as is now claimed by Mr. McKenna, then it should have been imposed for the past year as well as for the current year. But it is perfectly obvious that the change is made by him because, where the maximum of 5*s.* income tax is imposed, there will be exacted under the new Finance Bill 85 per cent.—namely, 60 per cent. for excess and 25 per cent. for income tax on the total profit, leaving 15 per cent. to the manufacturer. There can be no question, in view of these facts, that the Government, through Mr. McKenna, are breaking faith with the owners of controlled establishments, and although their patriotism will preclude them from resenting such breach of faith by any relaxation of the tremendous effort which they have made during the past 18 months, there is the less justification for the action of the Government. Most of our troubles, alike international and national, as well as in trade and commerce, are due to the non-fulfilment or the breaking of agreements. There is no need to enlarge upon this fact. In all such matters the Government should be exemplars. They cannot insist on trade unions or employers fulfilling any agreement they may make when they themselves show that so soon as an agreement is opposed to their immediate monetary interests it must be departed from or broken.

The peculiar conditions of all controlled establishments demand favourable consideration from the Government. Mr. McKenna himself, at a conference in company with the Prime Minister and the President of the Board of Trade on December 1 last, addressing delegates from all the trade unions throughout the Kingdom, enforced the truth that ultimately profit earned is added to the capital available for the development of manufactures and for the employment of the people. To-day he seems to have forgotten that maxim, notwithstanding that in all neutral countries—every one of them an immense potential competitor of our manufacturers—great profits are being already utilised for the development of manufactures and for the employment of the people of those countries, perhaps for the disinheriting of this country from our national right as a great manufacturing nation of the world. When the war is over we shall be set, as a nation and an empire, one of the greatest tasks that can be imposed upon any people. There will be need for every penny of liquid capital that can be found, as well as for the greatest amount of physical effort, in order to recover our industrial supremacy. The best of our establishments—one might almost say the whole of them—have been mobilised for the Navy and the Army. They have been disorganised. Their trade has been allowed to flow into other channels to the profit of other nations. At the same time factory owners have had imposed upon them the necessity of enormous works and machinery extensions, so that on both sides of the balance-sheet the conditions are adverse to profitable work in the immediate future. Thus, while it is sound national finance to pay as large a proportion as possible of the expense of the war from taxation or revenue, it is equally essential to the future financial stability of the country that the strength of the nation from the economic point of view shall not be sapped by too big a drain on that earned profit which, in Mr. McKenna's words, forms the necessary addition to the capital available for the development of manufactures and for the employment of the people.

THE DETERIORATION OF GAS-METERS.

WE have for some years been advised to restrict the burning of coal in wasteful domestic grates as much as possible and to rely upon gas for heating and cooking. As a consequence more gas is probably sent on average through a meter than used to pass through it, and complaints about accelerated destruction and depreciation of gas-meters have become very serious. Any increase in their renewals and repairs is financially a very serious matter for the gas companies, while the consumer is put to inconvenience and may suffer loss when a gas-meter gets out of order and records too fast. Whether the increased flow of gas, its quality and modifications in the process of gas-making, or whether modifications in the construction and materials of gas-meters, are responsible for the accelerated rate of destruction, is a question that can only be decided by a thorough and prolonged investigation. In view of the importance of the problem the Institution of Gas Engineers and the Society of British Gas Industries appointed a joint committee in October, 1914, to investigate the various conditions affecting the life of gas-meters, and the committee committed to their chemist, Dr. R. Lessing, the carrying out of an experimental research. Dr. Lessing presented his first report to the Institution of Gas Engineers at the annual meeting held on June 6. The report is only preliminary; it makes suggestions for discussion and further investigation rather than draws definite conclusions.

The terms of reference submitted by the committee for inquiry comprised the effects of the position of the meters when in use, liquids in the meters, the action of gas upon meters, the decay of leather diaphragms in them, internal corrosion, deposits on valve faces, naphthalene in meters, and the work put on meters in a given time. So far the inquiry has practically been restricted to dry meters, which are, on the whole, more numerous than wet meters. Meter-makers and gas engineers have been asked for information, visits have been paid to repair-shops, meter liquids have been collected and examined, and large numbers of samples have been tested of the oils (used for dressing diaphragm leathers), the blacklead (used with oil dressing), cuttings of the leather, cord or wire, tape and glue (used in fixing diaphragm leathers), and the tinplate (used for discs and cases). Manifold preparatory researches were evidently required. The position of the meter in draughty passages, &c., might favour condensation of liquid; the condensation may be due to cooling, to mechanical deposition of fogs of liquid particles, to the scrubbing action of the oil used for dressing the leather upon the constituents of the gas soluble in oil, and to the accidental flow of liquid into the meter. The conditions of cleaning (as distinct from purifying) and scrubbing the gas prevailing at present are not necessarily those of a few years ago; some of the aromatic hydrocarbons are now removed from the gas by scrubbing with oil or tar. Dr. Lessing has constructed an apparatus for estimating the condensible vapours in the gas, and he has arranged for "fatigue" tests on meters through which the gas is passed at their maximum capacity to hasten the end.

Analysis of the liquids found in meters by direct distillation and by distillation with steam proved difficult for various reasons, one of them being the strong tendency to priming of the liquids, which behave like emulsions, owing apparently to the extraction from the destroyed leather of a nitrogenous colloidal product and to the formation of metal soaps. To get over this trouble the liquid was first roughly separated into oily and aqueous layers, which were filtered before distillation; centrifugal high speeds proved more effective. The low boiling fractions of the liquids have the bad smell characteristic of gas-meters, which is due to sulphur compounds of the mercaptan type. The emulsions contain tin and iron; up to 33 per cent. of tin was found in the ashes of the liquid. Some blackleads contained 70 and even 80 per cent. of ashes, 16.5 per cent. of which was iron in one case. This iron must come from the tin plate of the case, while the tin is partly derived from the solder. Some of the corroding acid found also may be traced back to the hydrochloric acid, zinc chloride or ammonium chloride that had been used by the tinsmith; part of the acidity must be charged to the decaying leather. The leather used by meter-makers is usually tanned in India and Persia, and is manufactured largely for book-binding and art work; to facilitate their absorbing dyes the leathers are treated with sulphuric acid. The organic compounds in the gas are also responsible for part of the acidity, and it is noteworthy in this connection that the gas-meter itself acts as a scrubber in which certain impurities concentrate. Dr. Lessing found that one company, which had many meters to repair, admitted that the scrubbing capacity at the works was insufficient.

It is not only the acids, however, which attack the metals. Ammonia, free or in compounds, always found in gas-meters, is likewise destructive, and once the tin coating is injured, galvanic action hastens the corrosion of the iron. The recent substitution of tin-steel for tin-iron may also be of some importance. Cyanogen is another injurious constituent of gas, and its percentage has increased of late; for in spite of much advocating of low-temperature carbonisation and much experimenting in this field, high temperature carbonisation is not uncommon. At the same time lime purification has largely given way to iron oxide purification; the iron oxide should retain acids too, but it does not always seem to do so with very intense working, and the ammonia which is then passed into the purifier to prevent souring is destructive to the meter. The introduction of carburetted water-gas has further been held responsible for gas-meter deterioration. Dr. Lessing thinks that the use of petroleum hydrocarbons and tar distillates of comparatively high boiling points for removing the naphthalene—which in itself seems harmless to the meters, unless it clog them—is more injurious, as these hydrocarbons have a higher dew point than those naturally present in gas, and extract the oil dressing from the leather, which then decays rapidly. The recent proposals for spraying kerosene or lamp oil into gas must therefore be regarded with some concern by the gas-meter department.

The problems are evidently complex, and require a much broader statistical basis than was available. The question may broadly be put this way: Is the gas to be purified so as not to affect the meter, or should the meter be made capable of resisting corrosion by the gas? The gas engineers were not unanimous, either as to the object to be aimed at or as to the party most in fault, the gas-maker or the gas-meter maker; so far the gas appears to be more at fault than the gas-meter. One point deserves special mention. Dr. Lessing had quite recently been in America and had found that gas-meter corrosion had been acute there a dozen years ago, but was not so now, apparently because the gas-meter makers had combined; one factory attends to making the mechanical parts, and runs a tannery of its own for supplying the diaphragm leathers. Standardisation and common action always have advantages. Separate firms might spend considerable sums upon the investigation of the meter problem without settling anything, while concerted action should ensure much better results.

THE JOHANNESBURG ELECTRICITY SUPPLY.

THE failure of the gas-engine plant installed at the Municipal Electric Power Station at Johannesburg led to a very awkward position of affairs. When the plant was ordered in 1904, the recorded thermal efficiencies of gas and steam engines were such as to make the adoption of gas power very attractive, the more especially as there was then no great difference in the maximum size of the two types of generator commercially attainable. Nowadays, when steam-turbine designers are prepared, under favourable conditions, to guarantee a brake-horse-power hour for the expenditure of less than 9000 B.Th.U. per hour, circumstances have to be of a very special character to give the preference to gas where units of any considerable size are required, though, of course, the internal-combustion engine still retains all its thermodynamic advantages for small or moderate outputs.

When the gas plant was ordered for Johannesburg the total population to be served numbered 160,331, a figure which by 1911 had risen to 240,581, and in 1914 to 253,274. On the final abandonment of the gas plant in May, 1907, the demand for electric energy was such as to make emergency measures necessary, of which an interesting description is given in a paper recently read before the South African Institution of Engineers by Mr. J. H. Dobson, M.I. Mech. E., M.I.E.E. The aggregated

output of the steam plant available was, he states, only 1660 horse-power. In six weeks' time two 500-kw. non-condensing reciprocator-driven sets were procured and set to work, and by the end of the year another 1000-kw. set was in operation. During 1908 another two units of the same size and a third of half the capacity were also installed. These sets were supplied by Messrs. Belliss and Morcom, and the corresponding boilers by Messrs. Babcock and Wilcox, the erection being carried out by a local firm, Messrs. Reunert and Lenz, who made astonishing records. But famine prices had to be paid, and it was impossible to arrange the "lay out" of the engine and boiler rooms on other than emergency lines, thus leaving much reconstruction to be undertaken on the advent of some more convenient season. The load continued to grow and in 1909 was 5400 kilowatts, which was more than the rated capacity of the power stations.

Various proposals were considered as to how the situation was to be met. The actual total costs of generation (there being no stand-by plant) was 0.89d. per unit, and a supply was offered by the Victoria Falls Company at 1.305d. per unit, a figure which has, since the further development of this company, been amended to ¾d. per unit for a minimum of 4 million units per annum.

It was, however, decided to modernise and extend the municipal power station by the installation of steam-turbine-driven units of 3000 kw. capacity. Apparently this decision was not arrived at without some hesitancy, since some of the earlier steam turbines supplied to the Rand would appear to have proved anything but reliable. Indeed, Mr. Dobson observes that the agents for rival makers appeared to seek a decision in favour of their own plant on the ground of the unreliability of their competitors' wares. "Some had gone through the roofs of the engine rooms, whilst others had suffered from complete blade-stripping, &c." It is satisfactory to note that Mr. Dobson appears to have been completely satisfied with the three 3000-kw. alternator units supplied to him by Messrs. Belliss and Morcom. These are impulse turbines, fitted with Michell thrust-blocks. As cooling towers have to be used for the circulating water, a very low water-rate was not to be expected, and Mr. Dobson gives the following as typical of numerous special tests of steam consumption. The pressure was 175 lb. (gauge) at the stop valve.

Load.	Units per Hour.	Back Pressure. Lb. per sq. in.	Lb. of Steam per Unit Superheated to 540 deg. Fahr.
4/4	3100	1.28	15.146
3/4	2177	0.985	15.195
2/4	1527	0.866	16.01
1/4	829	0.714	17.46

Mr. Dobson observes that an analysis of the figures indicates that the blade efficiency of these turbines is 88 per cent. to 90 per cent. No particulars are given of this analysis, and the trial data certainly indicate that this estimate is much too high. Possibly it is based on the slope of the Willans line—a totally incorrect method, which is periodically being rescued from the oblivion properly appropriate to it. The over-all efficiency ratio at full load is (using Callendar's tables) about 64.2 per cent., so that the "hydraulic" efficiency of the turbine is probably also about 64 per cent., and as leakage losses, disc and bearing friction will hardly aggregate 6 per cent., the real value of the blading efficiency would appear to be of the order of 68 per cent. to 70 per cent., instead of the 88 to 90 per cent. given by Mr. Dobson.

The first turbine has, Mr. Dobson states, run perfectly for five years. A few months ago, however, signs of pitting appeared on the L.P. blades, and it was decided to replace them. Before the resolve to replace the blades had been given effect to a strip occurred, and, accordingly, when later on pitting appeared on the L.P. blading of a second turbine, it was decided to renew these blades at once, thus avoiding the risk of a strip. The third turbine, installed in August, 1913, has run without trouble up to date. Reviewing the performance of the turbines as a whole, Mr. Dobson expresses great satisfaction with their behaviour.

One of the most interesting items in Mr. Dobson's paper is the result of a comparative test of a large marine type Babcock and Wilcox boiler and a Bettington boiler of nearly the same size. The latter was the first of its type, and is no doubt capable of some improvement as the result of the experience gained. It will be seen, however, that it compared well with its older rival. The figures are as follow:—

Results of Tests on the Robeson-Bettington Boiler and the Babcock and Wilcox Marine Type Boiler.

Item.	Bettington Tests.	Babcock & Wilcox Tests.
Date of test	26.6.1913	27.6.1913
Duration of test	9.8 hours	10 hours
Gauge pressure	173.7 lb. per sq. in.	161.9 lb. per sq. in.
Feed temperature	65.5deg.F.	64.7 deg.F.
Steam temperature	510.3 deg.F	546 deg.F.
Water evaporated per hour ...	31,561 lb.	29,370 lb.
Coal consumed per hour. (No allowance made for carbon value of ashes)	4,477 lb.	4,183 lb.
Lbs. of water evaporated per 1 lb. coal (as fired)	7.050 lb.	7.014 lb.
Evaporative equivalent from and at 212 deg. Fahr. (as fired) ...	9.049 lb.	9.140 lb.
Evaporative equivalent from and at 212 deg. Fahr. (dry) ...	9.464 lb.	9.868 lb.
Efficiency on gross calorific value	78.6 p.c.	77.4 p.c.
Percentage auxiliary power ...	3.8 ,,	1.0 ,,
Net efficiency on gross calorific value	75.6 ,,	76.6 ,,
Efficiency on net calorific value	81.4 ,,	80.0 ,,
Net efficiency on net calorific value	78.3 ,,	79.1 ,,

The Bettington boiler consists of a cage of vertical tubes which are entered into annular headers at the top and bottom. The main peculiarity, however, consists in the firing of the boiler. The coal is pulverised and blown into the furnace space by means of hot air. In this space it burns as a vertical Bunsen flame. The power taken for pulverising the coal and for supplying the blast has been deducted in determining the net calorific efficiencies given in the table. A great advantage of the boiler lies in the fact that by using gas it can be started up from the cold in 20 minutes to half-an-hour. This property has proved of the greatest value at Johannesburg, where during the rainy season large increases of load develop at very short notice.

Another interesting test made at the station had as its object the comparative merits (under the local conditions) of under-feed and chain-grate stokers. The former proved to have many good points, they were much cheaper to instal, and had great flexibility, giving nearly perfect combustion at all loads. It was necessary, however, with the Transvaal coals to open the doors frequently for cleaning purposes, an operation unnecessary with the chain-grate stokers. The latter were accordingly found to be the more suitable for the conditions at the Johannesburg station, giving a higher evaporative efficiency in all the tests.

The circulating water for the condensers has to be cooled by towers, which were designed and made by the municipal staff. The water enters these towers through a 14-in. pipe, and is then sprayed through porcelain nozzles on to zinc plates and thence on to layers of brushwood below. These nozzles are simply ordinary leading-in tubes ⅝ in. in diameter by 6 in. long. They keep themselves perfectly clean. The water after it escapes through them strikes the zinc discs 9 in. below, from which it splashes off over the brushwood. There are seven tiers of brushwood, spaced about 2 ft. apart. An interesting feature is the piping for the circulating water, which is constructed of Californian redwood. These pipes have an internal diameter of 20 in., and are built up of staves, tongued and grooved, 3½ in. wide by 1½ in. thick, and bound together by $\frac{3}{16}$-in. steel wire. The couplings consist of collars 12 in. wide, built up of staves in precisely the same way. The ends of the pipe to be joined are tapered for 6 in. back, and the joint is made by forcing these ends into the collars after painting them with red lead. The pipes, Mr. Dobson states, are much cheaper than cast-iron and are easy to run.

THE NATIONAL PHYSICAL LABORATORY IN 1915-16.

(*Continued from page 606.*)

Metallurgy and Metallurgical Chemistry (Superintendent, Dr. W. Rosenhain, F.R.S.; Messrs. J. Murdock, S. L. Archbutt, Guy Barr, W. H. Withey, L. L. Bircumshaw, J. L. Haughton, T. E. Rooney, D. Hanson, E. H. Rodd, J. D. Grogan, N. P. Tucker, P. G. Ward, E. A. Coad-Pryor, H. W. Winter; Misses C. F. Elam and P. Routh; Dr. W. R. G. Atkins, volunteer assistant).—Several of the assistants mentioned are still on active service. The Department has been greatly occupied with special questions, and the optical glass research constitutes almost a new department of its own; thus the ordinary work has largely had to be suspended. *Equipment; Rolling Mill; Optical Glass.*—Three pairs of grooved rolls and two pairs of chilled rolls, supplied by the Brightside Engineering Company; further, a belt-driven power hammer by Messrs. Willcox have been added to the rolling-mill plant which we described last year;* the mill has been of great value for studies of light alloys, and has worked very satisfactorily, without disturbing the Laboratory by vibrations. The equipment for the optical glass research, which was started with a grant from the Board of Trade and is supported by a grant from the Privy Council Research Committee, has necessitated a complete re-arrangement of the foundry (part of the Wernher building), in which two gas-fired furnaces, designed and erected by the Department, and an electric furnace plant have been installed. The first gas furnace is a double kiln for preheating and annealing glass-melting crucibles up to 12-in. in diameter; the second furnace is a regenerative melting furnace fired with coal-gas and provided with a tubular regenerator; its Keith-Blackman fan is hardly required, as the 30-ft. stack carries off all fumes. The first problem studied is the replacement of the commercial refractory materials of the furnace and pots by more suitable materials; the nature of the problems of optical-glass making was recently reviewed by Mr. Rosenhain in his Cantor lecture.† At present the furnace can hold crucibles 12 in. in diameter, 16 in. high, and can be raised to 1,550 deg. Cent. in a day, the temperature and flame being well under control. The electric plant comprises a 50-kw. alternating current set, in which three-phase currents of 3,000 volts (from the Twickenham mains) are converted, by a static transformer, down to 440 volts, to drive a generator giving currents of 40 cycles at any voltage from 100 to 250; the transformer ranges down to 7.5 volts, so that 6,000 amperes are available. Various types of novel electric glass furnaces are under trial.

Thermostat Alloys Research. Systematic Study of Steels. Magnet Steels. The new thermostat for prolonged annealing has been described by Messrs. Haughton and Hanson before the Institute of Metals, before which Dr. Rosenhain also explained his plotting chronograph (which we illustrated last year) and microscope levelling device. The alloys research had been interrupted, but was resumed as urgent, the aluminium-zinc-copper alloys being studied in particular. The technological laboratory, to which we referred in our introductory remarks, is particularly needed for the study of refractories, of alloys, and of steels. As regards the systematic study of steels, the Privy Council Committee has pointed out that the developments in apparatus for taking thermal curves and for quenching and annealing make it desirable that these more accurate methods should be utilised for a re-investigation of the fundamental carbon steels and alloy steels, the importance of the latter for aeronautics being emphasised. The systematic study would involve determination of the melting point of iron *in vacuo* and of the effects of stress on steels at high temperatures. Mr. Haughton's investigation of magnet steels is undertaken on behalf of the Institution of Electrical Engineers.

Metallurgical and General Chemistry.—A critical study of the analysis of aluminium alloys was presented to the Institute of Metals last March by Mr. Withey. Steel drillings, it has been observed,

* See ENGINEERING, vol. c., page 28, July 9, 1915.
† See ENGINEERING, December 17, 1915, page 619.

should be annealed before carrying out the volumetric sulphur determination (the sulphur being evolved as sulphuretted hydrogen) certain steels, at any rate, are otherwise apt to give too low sulphur values. The testing of glass, porcelain and filter paper has shown in many cases that British products are at least equal to those formerly imported.

The William Froude National Tank (Superintendent, Mr. G. S. Baker, late R.C.N.C., M.Inst.N.A.; Mr. G. H. Millar, Mr. J. L. Kent, Miss E. M. Kearey, Mr. W. J. O. Studd, Mr. G. H. Bottomley).—The Advisory Committee of the Tank (which presents its report to the Executive Committee of the Laboratory) has, in response to an invitation from the Executive, been strengthened by the appointment of the following additional members, bringing the number up to 15: Sir Charles Parsons (North-East Coast Institution of Engineers and Shipbuilders); Sir Kenneth Anderson (Chamber of Shipping of the United Kingdom), Mr. P. D. Ewing (Institution of Engineers and Shipbuilders in Scotland), and Mr. Charles Livingstone (Liverpool Steamship Owners' Association). The practical stoppage of mercantile shipbuilding has caused a considerable diminution in model-resistance test work (only 18 models were tested, against 67 in 1914), but a very large amount of work of exceptional character has been undertaken for the Government, necessitating additions to the staff. The number of experimental test runs was 3,000, against 2,000 before the war. The annual test of the carriage rail level has been postponed. Mr. Millar's apparatus for testing floats for seaplanes (illustrated in ENGINEERING, July 31, 1914, page 166) has worked well. Special gear has been erected for testing the stability of the seaplane when under way; at top speed there may be quite a considerable variation in the transverse stability. Miss Kearey, of Newnham College, is the junior assistant for seaplane work. Buoyancy tests of life-saving and weight-supporting appliances under prolonged immersion and other experiments, are being conducted in the small tank by the Engineering Department. The model tests for firms fell off (as mentioned above) immediately after the war began; the best result obtained (in the 18 tests) was a 16 per cent. reduction of power at service speed.

Ship Resistance and Appendages; Plate Butts; Skin Friction and Temperatures; Struts.—Experiments on the effect of adding resistance to different parts of the hull longitudinally prove the importance of keeping all appendages from the bow. It was particularly tried whether the working of flush, instead of lapped, plate edges and butts near the bow would reduce the resistance. The effect of plate butts and edges is generally neglected or assumed to be covered by the use of plank results. Two models —one a very fine form, the other of large beam and full coefficient—have been tested. Lapped butts and edges were worked over the wetted surface in the common practice, the length of the plates being assumed as $\frac{1}{10}$ of the model length. The fine form showed an increase of 10 per cent. in frictional resistance at high and low speeds; in the full form the increase dropped to 8 per cent. at low speeds. The full form was further tested with the butts and edges replaced by flush surfaces over the foremost eighth of its length; the excess resistance was then diminished by one-half. Tests with the standard brass model having a sheet of calico wrapped round it at various longitudinal positions supported these results; a given area of calico placed near the bow gave far worse results than when placed elsewhere. The increase in the resistance due to butts and edges may not be the same in the ship as in the model, but it will exist to an undesirable extent. As regards the relation between skin friction and temperature,* Mr. Baker gave an account of his investigations last November before the North-East Coast Institution of Engineers and Shipbuilders, when he dealt with the experiments of Froude, Geber and Zahm, and with some plant-model tests made in the Tank. Plotting the VL/ν^3, where V is the speed of the plank through the water, L the length of the surface in the direction of motion, and ν = the quotient viscosity of the fluid μ by its density ρ; all the experiments for various plank-lengths can be expressed by one curve, provided the VL/ν^3 exceeds a certain value. In its logarithmic form the curve is practically a straight line, which produced (for ship calculation) gives resistances smaller than those obtained by W. Froude's method, when the length exceeds 200 ft. This matter requires further investigation. With respect to the temperature effect, model experiments indicated a diminution of the frictional resistance of 3 per cent. with a rise of 10 deg. Fahr., while the resistance curve just mentioned gave only 1.7 per cent. Taylor (at Washington) and Denny (Dumbarton) recently found 2.2 and 3.39 per cent., the former for models at high speed. At Teddington the temperature effect is found to decrease with increasing speed, and the original figure of 3 per cent. seems practically to be correct. The investigation of the strut resistance (compare last year's report), which has been studied in conjunction with the Engineering Department (Dr. Stanton and Mr. Pannell), has brought out a discrepancy between the values found in water and in air at high speeds, both with full-form and with fine struts. The question is not of importance for the ship resistance, as the difference occurs at quite low speeds in water; but it is of considerable importance for the struts of full size air-machines, and the problem needs further elucidation. The Advisory Committee record their high appreciation of the work done by Mr. Baker and the Tank staff, and their indebtedness to Dr. Glazebrook, the Director of the Laboratory. The combination of the Tank and Laboratory has borne excellent fruit.

* See ENGINEERING, July 9, 1915, page 29.

Physics Department. Electricity. Fundamental Units (Mr. F. E. Smith, A.R.C.Sc.).—Apart from work on standard resistances and Weston normal cells, the time of Mr. Smith has been spent in investigations of a confidential kind, in which Mr. G. W. White, of Cambridge, and Mr. F. B. Pidduck, of Oxford (both now at Woolwich), and later Mr. H. C. Napier, of Oxford, have assisted.

Compasses, Prismatic and Liquid.—The testing of liquid compasses was undertaken for the Board of Trade, and that of prismatic compasses for the Inspector of the R.E. Stores at Woolwich. New arrangements have been designed for expeditious testing at the rate of 1,000 compasses per week. At Woolwich Mr. Smith organised a staff of ladies for compass-testing in the Woolwich Inspection Department, and he dealt in a thoroughly practical way with many aspects of the problems in a paper on "The Manufacture and Testing of Prismatic Compasses, especially Mark VII, Military Pattern," read before the Optical Society last winter. This paper, which does not confine itself to prismatic compasses, has been reprinted for distribution by desire of the Ministry of Munitions; it discusses errors to which compasses are subject, and tells the manufacturer how to test for them and how to avoid them. One of the greatest troubles of the manufacturer is that, even if his own testing room should be free from sources causing magnetic fluctuation, neighbouring electric machinery may change the direction of the magnetic field by several degrees. A non-magnetic hut, such as Mr. Smith erected at Teddington, is mostly out of the question; but Mr. Smith was able to show how the tests can be made anywhere with the aid of a good standard compass, a centring table and a strong bar magnet. As regards liquid compasses, the Board of Trade desired a specification for the use of such compasses on life-boats, and sent 16 of the instruments, which had done service in merchant ships, to Teddington, where they were tested in the usual way and then unsealed for the examination of floats, pivots and liquids. The liquid of these compasses, a small form of which is now also much used on land, is to serve two purposes: First, to produce buoyancy of the card and thus to reduce the weight on the pivot and the friction between the bowl centre and the point of support, prolonging the effective life of the compass; and, secondly, to produce damping, as a compass should be dead beat. The whole chamber is completely filled with the liquid (water mixed with alcohol or glycerin); but there is generally a small air chamber at the base of the bowl, the upper wall of which is thin metal. Suggestions have been made for the improvement of liquid compasses.

General Electric Measurements. Magnet Steels, Straight and Curved Bars (Mr. A. Campbell, B.A., Mr. D. W. Dye, B.Sc.).—A new inductometer of wide range, 0.2 to 35 millihenry, for high frequencies with flat coils, and three new vibration galvanometers of high current sensitivity, the one for low frequencies (10 periods and less per second), have been constructed. The enclosed Poulsen arc lamp for high frequency, after R. Lindemann (Reichsanstalt) and oil-condensers for wave-meter tests, are further novelties.

Most of the other work, of which the importance has been increased by the war, has been confidential, and we can only refer here to the magnetic tests —undertaken for the Institution of Electrical Engineers—and in particular to the determination of remanence and the coercive force. The improvements introduced involve the use of the very thin, flat search coils for measuring H, following Mme. Curie, Denso, Gumlich and Rogowski (see ENGINEERING, July 23, 1915, page 64). Such coils placed very close to the surface of the iron bar admit of accurately measuring the field at that portion, even with complex fields (due to several sources, solenoids, other magnets, or leakage from free poles of the rod itself). For rectangular bars the coils are wound on thin sheets of glass and arranged in a very narrow frame, which, when a thread is pulled, rotates through 180 deg. in its own plane; a ballistic galvanometer or fluxmeter then gives the H, and when H is reduced to zero, the B, so that the remanence can conveniently be determined. This turning coil can be used also with curved bars of moderate curvature. Round rods require tunnel-shaped search coils, to which dynamic rigidity and permanence of form is not easily imparted. Horse-shoe bars cause more difficulty still, because a sufficient number of turns of uniform winding have to be crowded into a small space for fields of 300 or 400 units, and a variety of sectioned coils have been constructed for this purpose. The commercially important test of highly magnetic (B = 20,000 *e.g.*) cast steel is performed by placing a rod of the material axially in a heavily-wound wide solenoid, clamping the rod between the ends of two soft-iron rods in line with it and abutting against its ends. The H is determined by one of the search coils described, the B by a coil of one or two turns round the middle of the rod. Some standard rods of the Ewing permeability bridge, originally tested by the small yoke method, have given results by this method in very satisfactory agreement with the old tests.

Messrs. Campbell and Dye, assisted by Mr. H. C. Booth, have in this connection also investigated the Chattock magnetic potentiometer, a simple arrangement for directly measuring the magnetic potential between any two accessible points, which was described by A. P. Chattock in 1887, and has recently been applied in various ways by Rogowski and Steinhaus, for testing the magnetic joints between a rail and the shoe of a track brake and for testing transformers and other apparatus. The essential part is a flexible flat strip, *e.g.*, of presspahn uniformly wound with insulated wire. Mr. Campbell finds the arrangement very convenient, for instance, for determining how many turns of a coil would be wanted for a particular purpose. The magnet steels to be tested are first examined for their thermo-magnetic properties in the form of small rods, 0.5 mm. in diameter, which are chilled at their proper temperature, and then tested for permeability, remanence and coercive force. Similar tests are subsequently applied to the original forms, thicker rods, of 2.5 or 1.5 cm.; the method of chilling has also been studied.

(To be continued.)

NOTES.

THE RESISTANCE TO COLLAPSE OF CORRUGATED SHEET-METAL PIPES.

AN elaborate investigation into the strength of corrugated sheet-metal pipes for use as culverts is described by Mr. G. L. Fowler in a recent issue of the *Railway-Age Gazette*. Three different sizes of pipe were tested—viz., 12 in., 24 in., and 48 in. in diameter. They were constructed of sheet iron, and were corrugated to increase their strength against collapse. Each diameter of pipe was tested with two different depths of corrugation and with four thicknesses of metal—viz., 16 gauge (0.0625 in.), 14

gauge (0.078 in.), 12 gauge (0.109 in.), and 10 gauge (0.141 in.). The pipes were tested in 12-ft. lengths in order to make certain of avoiding the disturbances due to the end effects. The tests were made by subjecting them to an external hydraulic pressure. Under this collapse always took place suddenly. This caused a fall of pressure, and it was impossible by further pumping to again attain the maximum pressure. Tests made at the same time of 12-in. pipes, of the same thicknesses of metal, but not corrugated, gave the following comparative results:—

Gauge of Metal.	Collapsing Pressure; Lb. per Sq. In.		
	Smooth Pipe.	Corrugations ½ in. Deep.	Corrugations ¼ in. Deep.
10	130	450	630
12	80	420	490
14	40	275	380
16	37½	225	360

The following were the results of the complete series of hydraulic tests in the corrugated pipes:—

Diameter of Pipe.	Gauge of Metal.	Depth of Corrugation.	Collapsing Pressure.	Diameter of Pipe.	Gauge of Metal.	Depth of Corrugation.	Collapsing Pressure.
in.		in.	lb. per sq. in.	in.		in.	lb. per sq. in.
12	16	½	225	24	16	½	100
12	14	½	275	24	14	½	100
12	12	½	420	24	12	½	180
12	10	½	450	24	10	½	320
12	16	¼	360	48	16	¼	15
12	14	¼	380	48	14	¼	20
12	12	¼	490	48	12	¼	33
12	10	¼	630	48	10	¼	58
24	16	¼	52	48	16	½	29
24	14	¼	75	48	14	½	39
24	12	¼	130	48	12	½	45
24	10	¼	160	48	10	½	70

THE "NICK AND BREAK" TEST FOR STEEL RAILS.

In a report recently made to the American Railway Association by Messrs. Robt. W. Hunt and C. W. Gennet, Junr., stress is laid upon the advantages of the "nick and break" test for steel rails. The authors recall that in the early days of steel manufacture, when the works chemist was unknown, crucible steel was graded entirely by the appearance of the fracture. In the early eighties there was, it appears, much dissatisfaction with the quality of the steel rails often supplied, and Mr. Wm. Metcalfe advised the Rail Committee of the American Railway Association that the current methods of testing did not go far enough, and that several pieces of rail from each heat should be broken. This suggestion was not adopted at the time, but later on railway engineers did increase the severity of the tests, and it became the general practice to break, say, three pieces from each heat of open-hearth steel, and to accept or reject certain rails according to the results observed. It was argued that the process should be extended to include the breaking of a piece of rail from the top end of each ingot rolled; but the plan was opposed by the steel-makers, and failed to have a fair working trial until, about a year ago, the Algoma Steel Corporation of Sault Ste. Marie, Ontario, Canada, took a contract for the supply of 10,000 tons of rails to the Canadian Pacific Railway, the terms of which required "the nick and break test for each ingot." This contract was followed by others for rails to be shipped to the United States under similar test conditions. The test requires first the "nicking" and then the breaking by a "Bulldozer" of a short length of rail from the top of each ingot rolled. The crop end is naturally used. These are ordinarily 18 in. to 24 in. long, and after stamping with the heat and ingot number are allowed to cool for some 30 minutes at which time their temperature is low enough for them to be cooled with water without risk of affecting the structure. The test-pieces are then nicked and broken. The time taken is small, as the fractures are ready for judging in about an hour after the rolling, and often long before the drop-test pieces are cold enough to test, and even before the rails represented have reached the cold straightening presses. When the original fracture is bad the top rail of the ingot is rejected, and a fresh test made of a rail from the bottom of the same ingot. The judging of the fractures requires the services of experienced and competent men, but the authors observe that rail inspectors of this kind are required if any test whatever is to be satisfactory to both makers and purchasers.

THE GENERATION OF ELECTRIC ENERGY FROM LIGNITES.

A typical installation for the utilisation of lignites for the generation of electric energy is that at Weisweiler, close to Acken, which has now been working for a couple of years. The fuel used is exclusively natural lignite with a heating value of only 2700 B.Th.U. (as against 13,000 for good boiler coal) and about 64 per cent. moisture. The lignite is obtained from surface workings, and by means of a chain haulage system is transported to the power station and the adjoining briquette works. The bunkers of the power station, divided into six sections, have a capacity of 2500 tons. The lignite is first sorted and broken up and is then transported to the bunkers and the briquetting works. From the elevated bunkers the lignite falls direct, through pipes, on to the boiler grates, having previously been automatically weighed. The boiler installation consists of six tubular double boilers, each having 450 sq. m. (4844 sq. ft.) heating surface in contact with the water, in addition to the economiser. The steam pressure is 14 atmospheres, the steam by superheating being raised to a temperature of 380 deg. Cent. Chemical analyses of the raw lignite show 2.19 per cent. of ashes, and allowing for a small percentage going up the chimney, the ashes to be removed have never exceeded 1.8 per cent. of the weight of the lignite used. The current is generated by two 7500 k.v.a. turbines. The voltage is 5000 and 25,000 volts. It is of considerable interest to compare the financial results of the two applications of lignite: for the generation of electric energy and for briquette manufacture, the latter of about 9000 B.Th.U. With a practical heating value of the raw lignite of 3000 B. Th. U., about 35 tons of lignite were used for the production of 10 tons of briquettes. The selling price of this quantity by the Cologne syndicate, immediately before the war broke out, was 75 marks, at Libear. The cost of manufacture in briquetting amounts at least to 15 marks, and other expenses brings the total cost to 37 marks per 10 tons briquettes, leaving 38 marks, or 10.85 marks per 10 tons of lignite. The quantity of lignite used at Wiesweiler for generating 1 k.w.h. does not exceed 4 kilogs., consequently 10,000 kilogs. of lignite will produce 2500 k.w.h. Putting the value of this quantity of lignite at 10.85 marks, according to the above valuation in connection with the briquette manufacture, the lignite cost per k.w.h. is 0.434 pfennig, additional working cost amounts to 0.18 pfennig, and writings-off, interest, &c., to 0.385 pfennig per k.w.h., making the aggregate cost 0.999 pfennig per k.w.h., or, say, 1 pfennig. Electric energy has been sold at this extremely low figure for very large demands at the new Bitterfeld electric central station, also working with lignite, but without doubt a considerably higher price can usually be obtained for electric current. Supposing that half of the 60,000,000 k.w.h. from the enlarged Weisweiler central, was disposed of for chemical, electrolytical and similar manufactures, and the other half sold at an average price of 2.6 pfennig per k.w.h., this would make an average for the whole 60,000,000 k.w.h. of 1.8 pfennig. The advisability of more extensively using lignite for the production of electricity is further emphasised by the fact that there are poor lignites, which do not lend themselves to briquette manufacture, but which can be used as fuel under boilers.

IRON ORE OUTPUT IN THE UNITED STATES.—We read in the *Iron Age* that the iron ore mined in the United States in 1915 was 55,526,490 gross tons, the greatest output of any year except 1910 and 1913. The quantity mined in 1915 was an increase of 14,000,000 tons over the output for 1914. The yield in Minnesota was 33,464,660 tons; that in Michigan, 12,514,516 tons; in Alabama, 5,309,354 tons; in Wisconsin, 1,095,388 tons; in New York, 998,845 tons.

THE ROYAL AGRICULTURAL SOCIETY'S SHOW.

THE Royal Agricultural Society decided to hold their show at Manchester this year in spite of the probability that under the existing conditions the enterprise would not prove a financial success, although excellent results have been recorded at Manchester under peace conditions. In fact, Manchester holds the record for attendance at a six days' show. This year the implement section is sadly depleted, only 239 stands being occupied, or not more than 50 per cent. to 60 per cent. of the normal. Moreover, although many firms patriotically decided that it was their duty to support the Society by taking the same space as heretofore, they have in a number of cases been unable to do more than "put in an appearance," being unable to exhibit even a single machine. Most of them are "controlled" firms, and as such have had to sacrifice, in the interests of the State, business connections which have required years to establish, and which can only be made good again at the cost of much hard work and heavy expenditure. The general public, and the House of Commons, which represents it, is perhaps far too prone to consider too exclusively the purely material side of our manufacturing industries, the labour and the plant, and does not appreciate the truth of Andrew Carnegie's declaration some years ago that he would suffer less injury by the total destruction of his works than by the destruction of his "organisation," which, of the two, would be much more difficult to re-establish. Further, in some cases, firms, in their anxiety to meet the urgent need for shells, which arose some months back, pressed into the service fine machinery suitable only for a lighter class of work, and this has been permanently ruined. Even with a heavier class of machinery, with so much unskilled labour employed, depreciation has naturally been high. All these considerations will have in fairness to enter into the final audit of account between the Treasury and the controlled firms. The removal of trade-union restrictions, most of which are ethically indefensible at the best, has been no benefit whatever to many of our makers of agricultural machinery, since their shops were non-union, and of course it would, from the mere monetary standpoint, have been far more advantageous to them to have stuck to the production of their staple products, for which the demand has become insatiable. As matters stand, they made over their works, *con amore*, to the production of every variety of army and navy requirements, from 3-in. shells up to mines, buoys for submarine nets, and aeroplanes, in addition, of course, to what is more in line with their legitimate business—viz., the provision of the tractors which have ensured the success of our land transport. The authorities have, however, made some concession to the urgent need for more agricultural machinery which has become the more insistent with the further enlistment of farm labourers. In doing this, however, it has been in the nature of things impossible to hold the scales fairly even between different firms. Whilst some are limited to 1 per cent. or 2 per cent. of their former output, others, with works less well adapted to military needs, have been given a somewhat greater latitude.

STEAM-ENGINE EXHIBITS.

These are far fewer, both in number and variety, than in previous years. The relative importance of this section has been for long steadily diminishing in view of the increasing popularity of oil or petrol-driven machinery. The main factor in the smallness of the exhibit is, however, due to the fact that, as already stated, builders are one and all engaged on munitions of one sort or another, and further, somewhat less latitude has been allowed this year in classifying engines as suited to agricultural needs. Ordinary horizontal and vertical steam engines are accordingly conspicuous solely by their absence.

Messrs. Aveling and Porter, Limited, of Rochester, have as their principal exhibit a compound road locomotive (rated at 8 nominal horse-power. This has 7-ft. drivers, spring mounted. Their other exhibits comprise two of their standard 8-ton road-rollers,

it being impossible under actual conditions to put on the stand specimens of other classes of work as had been originally intended. Not only have this firm little more than one-third their old hands remaining, but those left are engaged almost exclusively on Government work, and the output of the firm's regular lines has in consequence fallen to small fractions of its former figure.

Messrs. Richard Garrett and Sons, Limited, of Leiston, have as their principal exhibit a portable engine designed to work with superheated steam. This engine is capable of developing 45 horse-power on the brake, and being fitted with a feed-heater, in addition to a smoke-box superheater, is very economical in fuel. A point which should be noted are the safety caps fitted over the keys at each end of the crank-shaft. These present a perfectly smooth surface and obviate completely the danger of the attendant's clothing being caught as he moves round the engine. A simple ratchet-operated barring gear is provided for getting the engine off the dead centre when starting up. In addition to the foregoing, Messrs. Garrett also show two portable engines designed for saturated steam. Of these the smaller is rated at 17 brake horse-power and the larger at 22 brake horse-power. It will be noted that this firm are now rating their engines in accordance with the actual output, having discarded the time-honoured nominal horse-power. Corresponding attempts in the past have been abandoned in view of the conservatism of our farmers, but the advent of the petrol and oil engine, which are always rated on their brake horse-power, would seem to make the time propitious for the reform, which is long overdue.

Messrs. John Fowler and Co. (Leeds), Limited, were unable, in view of munitions requirements, to send as extensive an exhibit as in past years. It was not possible to show, for example, one of the powerful steam ploughing engines with which the name of this firm has been so closely associated for many years. Two road locomotives are, however, staged. Of these the one represents the established steam engine-practice of the firm, the other being an internal-combustion tractor. This is fitted with a 50-horse-power engine designed to work with petrol or benzol. In its general appearance it follows closely the lines of the steam-driven traction engine, the gearing being carried in the space occupied by the firebox of the latter. It is completely enclosed and protected from dust by the "firebox" casing. The barrel serves as a fuel tank, the side plates being extended to take the engine. This has four cylinders cast in pairs. There are three speeds forward and one in reverse. The wheels follow standard steam-engine practice. In working order the weight of this tractor is about 9 tons.

Messrs. Marshall, Sons and Co., Limited, of the Britannia Ironworks, Gainsboro', are only able to show two engines, the one being a 7-nominal-horse-power traction engine and the other a portable rated at 6 nominal horse-power, both being established standard patterns. Indeed, were the workshops free for the making and testing of new designs, the present shortage of draughtsmen would make the preparation of plans impracticable as drawing offices in general have suffered severely from the combing-out process. In the case of one of the smaller firms at the Show, the process has been so drastic that only a single draughtsman remains. Messrs. Marshall must undoubtedly also have lost many from their drawing office, since, taking all departments of the works into consideration, no fewer than 2,500 men have left the shops for the Army. Their places have been filled so far as practicable by girls, whose activities were shown at the stand by three large coloured photographs. Two of these workers, in fact, clad in their khaki overalls, formed perhaps the most striking feature this year of Messrs. Marshall's stand.

As in previous years, Messrs. Robey and Co., Limited, of Lincoln, have taken a large stand, but the exhibits, which in normal years would have filled this to overflowing, are represented solely by photographs, the demand for munitions of one kind or another being too insistent to make possible the exhibit of even one specimen of the various classes of agricultural machinery for which this firm is famous.

The principal exhibit at the stand occupied by Messrs. Ruston, Proctor and Co., Limited, of Lincoln, was the 10-ton road-roller which is illustrated on page 620; our illustration, however, not showing the awning with which the implement is fitted. This has a compound engine designed to work with steam supplied at an initial pressure of 140 lb. per sq. in. The driving wheels are 5 ft. 2 in. in diameter by 17 in. wide, whilst the front rolls measure 3 ft. 7 in. in diameter by 42 in. total width. The breadth rolled is 6 ft. 1 in. Adjustable spring scrapers are fitted to the back rolls. The second countershaft is mounted in a "cannon" bracket which extends across the whole distance between the horn-plates, to which it is riveted at both ends. This method of supporting the shaft results in a very rigid job. The front and back plates of the external fire-box are extended up in the usual way above the external fire-box crown to take the engine, but to inrease rigidity they are both flanged at their free edges. Mechanical lubrication is provided for the cylinder. The hind axle is fitted with renewable brass bushes. Two running speeds are provided for—viz., 1½ and 3 miles per hour, the change being controlled by a single lever.

Messrs. J. and H. McLaren had intended to show one of their steam tractors which gained the Gold Medal of the Society in 1910, but were only able to stage a road locomotive of 50 effective horse-power. This is fitted with both superheater and feed-heater, and means are provided by which the superheater can be cut out if desired and the engine run on saturated steam. The boiler pressure is 195 lb. gauge, and the usual steam temperature with the superheater in action is between 450 deg. and 500 deg. Fahr. The engine has cylinders 5 in. and 8 in. in diameter by 12-in. stroke, and it weighs 8¾ tons in light condition, and is thus suitable for direct ploughing. Three running speeds are provided for. As others, Messrs. McLaren have been mainly engaged on work for the nation, being very busy with the shell-stamping machines, special chucks and other tools for munition workers already described in our columns.

Messrs. Clayton and Shuttleworth, Limited, of Lincoln, have on view three of their standard engines, but were unable to show, as they wished, a specimen of their steam wagons owing to the urgency of the demand. One convoy of 15 of these which has been at the front for 10 months has, it is stated, not cost 5s. for repairs during that period.

Mann's Patent Steam Cart and Wagon Company, Hunslet, Leeds, show a modification of their tractor, which has been specially designed to meet agricultural needs. The weight empty is 4¼ tons, which is distributed over a gross wheel width of 4 ft. 8 in. The front wheels and back wheels do not track with each other, but the tracks made by the front wheels lie between those of the driving wheels. A compound engine is fitted with cylinders 4 in. and 6½ in. by 7 in. stroke, taking steam at 200 lb. gauge pressure, and the boiler is the firm's standard side-fired locomotive pattern. The water-tank straddles the whole rear of the engine and its flat top can be used as a platform for the carriage of goods. Three changes of speed are provided for, and the tractor is, moreover, fitted with a winding drum.

Internal-Combustion Engines.

The Ministry of Munitions decided that no oil engines of the ordinary type were to be exhibited, being of opinion that the mechanics required to erect and adjust these on the ground could be more advantageously employed. A large number of oil and gas-engine builders accordingly decided not to take space this year, and other firms who build gas and oil engines in addition to agricultural implements exhibit the latter only. Messrs. Blackstone and Co., Limited, of Stamford, for example, have in previous years made an exhibit of oil engines the principal attraction to their stand, but on the present occasion have on view agricultural implements only. In any case, however, their exhibit could hardly have been as comprehensive as in previous years in view of the fact that the works are now engaged mainly on work of direct national importance.

Messrs. Ruston, Proctor and Co. are able to show neither oil engines, gas engines, nor producers. A case of samples is, however, on view at their stand, which sets forth the wide range of fuels with which both oil engine and the gas-producer plants are now being operated. Gas is, in short, being made from practically anything that will burn, from anthracite at the one extreme to the leaves of the sugar cane at the other.

Messrs. Petter's, Limited, of Yeovil, occupy the same space as in previous years, but in consequence of the decree of the Minister of Munitions are able to show nothing but photographs of plants supplied for different purposes. Amongst these we noted a number of lighting plants ranging in output from 5 brake horse-power up to 300 brake horse-power. A 70 horse-power marine engine was also illustrated, the type being one which has proved very suitable for some naval needs.

Another firm which occupied space but was unable to exhibit was the Worthington Pump Company, Limited, of India House, Kingsway, who are acting as agents for a variety of small oil and petrol engines of American manufacture. Some of the American firms affected have ingeniously evaded the regulations by holding an exhibition of their own outside the grounds, where their engines could be seen in motion.

Martin's Cultivator Company, Limited, of Stamford showed one of their motor ploughs. As this was fully illustrated and described in our issue of December 10 last, page 599, we will only recall the fact here that the machine is supported on the ground through the intermediary of two "caterpillar" chains; the weight is thus distributed over a large area and soft soil can be traversed without difficulty.

Owing to the restrictions placed on British manufacturers, American makers of agricultural oil and petrol engines and tractors are more in evidence this year than hitherto, having facilities for deliveries which are denied by circumstances to our own builders. Messrs. R. Hornsby and Sons, Limited, of Grantham, for example, are able to make no exhibits whatever, though they occupy a stand as usual. Moreover, with respect to such commercial work as they are still able to undertake, it has been deemed wise that the firm should devote themselves to the harvesting machinery department of their premises rather than to the making of oil engines, an industry which owes much to their courage and initiative in its pioneering stages. As matters actually stand 95 per cent. of the present activities of the firm are devoted to military ends.

Messrs. Saunderson and Mills, Limited, of the Elstow Works, Bedford, have largely redesigned their Universal tractor. The new pattern is illustrated on page 621. Its construction has been greatly simplified. The number of individual small parts has been reduced to one-half, and the further changes made have resulted in the running weight of the 20 horse-power tractor being reduced from 3 tons 5 cwt. to 2 tons 9 cwt., all on. The large water-tank for cooling water, formerly mounted in front of the engine, has been replaced by a copper gilled radiator, the surface provided being 8 sq. ft. per brake horse-power. The fan for this radiator expels the air out in front of the engine, thus saving the driver from the warm blast, which in hot countries has proved very trying when the opposite plan usual in motor-cars has been followed. The foot-plate has been remodelled and is now both roomy and very conveniently arranged. The gear-box is situated immediately in front of this foot-plate. The change gear and reverse levers pass to it, therefore, directly without the need of connecting links. The two are interlocked in a simple but effective fashion, so that it is impossible to operate the reverse lever unless the change-speed lever is in the proper place, and similarly the change-speed lever cannot be shifted with the reverse lever in position for running backwards. Three speeds are provided for in forward gear and one in reverse. Forced lubrication is fitted throughout. The engine is equipped with a variable speed governor, which can be set from the foot-plate to govern at 400, 600 to 800 revolutions per minute respectively, the change being made instantaneously without stopping the engine. The engine is intended to be started on petrol and to run subsequently on paraffin. By improvements effected in the paraffin carburettor the change over from the spirit to the oil can be made 30 seconds after starting, so that a couple of tablespoonsful of petrol suffice. The heater for the paraffin is adjustable, the proportion of the exhaust gases passing through it being varied at will. A

half-compression device is fitted and greatly facilitates the starting of the engine.

Messrs. Cyrus Robinson and Co., of 34 to 35, Queen Anne's Chambers, London, S.W., exhibit the "Bull" tractor built at Minneapolis, U.S.A. This is shown attached to a plough, the special feature of which is that the handles controlling it point forward instead of to the rear, and can be therefore reached by the engine man when on the foot-plate. The combination is accordingly claimed to constitute a "one man unit."

This tractor has a horizontal engine which is capable of developing 20–25 horse-power on the brake. The effective horse-power at the drawbar is 7–10. The machine rests on three wheels arranged so that the greater proportion of the weight is borne by the wheels in the furrow. Actual weighings show that on the front wheel the load is 8 cwt., on the land wheel 9 cwt. 2 qr., whilst the driving wheel carries 21¾ cwt. Both the driving and the steering wheels run in the furrow, and the alignment is such that the machine will, in uniform ground, run straight, automatically. The fuel consumption is stated to be 2 gallons per acre, the ploughing of which requires between 1½ to 2 hours. In starting petrol is used, but subsequently the engine is run on paraffin.

The Daimler Company exhibit a petrol-driven agricultural tractor fitted with a sleeve-valve engine, having 4 cylinders 110 mm. in diameter by 150 mm. stroke. The engine is the same as is supplied to military tractors and has thus been exhaustively tested in the severest conditions. Two speeds are provided in forward gear and one in reverse. The front wheels are 3 ft. 9 in. in diameter, and the drivers 6 ft. in diameter, the width being varied to suit the purchaser's requirements. A winding drum is fitted on the rear axle. The cooling-water tank has a capacity of 30 gallons, and the engine is capable of exerting a draw-bar pull of 4,000 lb. One great advantage of these powerful tractors lies in their capability of making the most of short spells of favourable weather At certain seasons of the year a farmer who works with horses would be glad to have three times his normal number, but during the rest of the year would have no work for the excess, and hence has to manage without. It is in this connection that these powerful tractors are proving so profitable, as when not in use their cost of upkeep is insignificant, whilst horses would be eating their heads off.

The Ivel Agricultural Motors, Limited, of Biggleswade, show a motor of 24 brake horse-power suitable for all kinds of agricultural work. It is capable of hauling a 3-furrow plough, a cultivator, binder or mower, and can also be used for driving fixed machinery. The engine has two cylinders with both magneto and coil ignition. It can be operated either with petrol, paraffin or alcohol. One speed is provided for in each direction. The machine is shown attached to a plough of Canadian make, which the tractor builders state they have found particularly suitable for use with their machine.

Wyles Motor Ploughs, Limited, of 5, Carr-street, Manchester, show two of their motor ploughs, each fitted with a single-cylinder engine developing 11 brake horse-power. The engine is fitted with magneto ignition and the lubrication is automatic throughout. Two speeds are provided for, the gearing is entirely enclosed and runs in an oil bath. The implement is entirely self-contained, and in addition to ploughing can be used also for driving fixed machinery, and by a further attachment, which we hope to illustrate later, can also be adapted to haulage. Either driving wheel can be uncoupled at will by shifting a dog-clutch, an arrangement which greatly facilitates the making of sharp turns. The level of each of these wheels is, moreover, capable of independent adjustment, so that one may run in the furrow whilst the other rides on the land. The total weight of the implement is 21 cwt., ploughs included.

Messrs. Fairbanks, Morse and Co., Limited, of 85, Southwark-street, London, S.E., show a light 4-wheeled farm tractor of American make fitted with a horizontal engine rated at 20 brake horse-power.

A 24 horse-power tractor is exhibited by the Overtime Farm Tractor Company, 124 to 127, Minories, E.C. This has a horizontal engine with two cylinders, each 6 in. in diameter by 7 in. stroke. On the brake this engine will develop 24 horse-power and at the draw-bar 12 horse-power. The main bearings are 5½ in. long by 2½ in. in diameter. Magneto ignition is fitted and the fan for the radiator runs on ball bearings. Petrol is used in starting up the engine, which once hot is operated on paraffin. The driving wheels are 52 in. in diameter by 10 in. wide. Provision is made for fitting extensions to these rims in special circumstances, but as the total weight of the tractor is but 39 cwt., it has not so far been necessary to make use of these in this country.

An oil tractor which appears at the Show for the first time is styled the Omnitractor, and is shown by the Omnitractor Syndicate, Limited, of 18 and 19, Great St. Helens, London, E.C. We publish complete drawings of this machine on pages 616, 617, 618 and 619, on which pages also will be found a detailed description.

Miscellaneous Exhibits.

Miscellaneous exhibits showed little this year either in the way of novelty or variety. Nevertheless, this section provided the sole exception to the rule that the exhibition of machinery in motion was prohibited. At two stands, occupied respectively by Mr. J. Webster, of the Palace Street Works, Bolton, and by Messrs. Thomas and Son, Limited, of the Climax Works, Worcester, pumps operated by windmills were shown in action.

Messrs. Ruston, Proctor and Co., of Lincoln, had on view some centrifugal pumps. This firm has supplied pumps of this type, operated by suction-gas plants, for drainage purposes on a large scale, pumps up to 36 in. in diameter being employed.

Messrs. Tuke and Bell, Limited, showed their semi-septic plant for sewage purification. This consists of a closed tank constructed in ferro-concrete, in which the primary septic reactions take place under anaerobic conditions. From this tank the effluent is delivered through a rotating sprinkler to a bacteria bed or filter. The rotation of the sprinkler arms is effected not by the reaction of the escaping fluid, but by its weight. The effluent from the tank flows, in fact, into one of two tipping buckets. When the bucket tips it causes the sprinkler to revolve over the bed. However slow may be the supply of effluent, rotation of the arms is thus ensured. These arms are, moreover, open channels with notched sides, through which the effluent is delivered. The notches cannot be blocked by detritus, as may occur when the arms are perforated pipes.

A small water-softening plant was also on view at this stand, but as we hope to illustrate this in our next issue, its description may stand over.

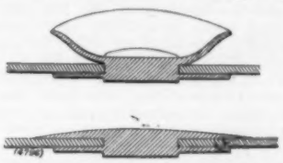
An exhibit of considerable interest is made by the Manchester Corporation, who have undertaken the supply of humogen, the bacterised peat discovered by Professor Bottomley, of King's College, London. This material promises to prove of great economic importance, since it is claimed that it possesses, in addition to special qualities of its own, many of the advantages of natural manures, the supply of which is failing owing to the increasing displacement of horse traction by the motor. The Government, it will be remembered, refused assistance to Professor Bottomley on the ground, as the intelligent official framed it, that the process was still in an experimental stage. Much water has passed the bridges since this pronouncement, which it may be hoped will mark the closing of the old era and the commencement of a better state of affairs, in which ignorance of scientific methods and principles will prove an effective bar to promotion in the public service. In the present case Manchester came to the rescue, and is prepared to supply the new material in quantity.

Not merely neutrals, but our daily Press have regarded with some awe Teutonic boasts of their success in extracting nitrogen from the air for use in making explosives. As Kipling observes somewhere:

> "The English; ah, the English don't say anything at all,"

but a notice exhibited at the stand of the Nitrogen Fertilisers, Limited, states that the whole of their product has been requisitioned for the making of munitions. As a matter of fact, it was Sir William Crookes who first suggested that the extraction of nitrogen from the air, known at that time to be feasible in the laboratory, was capable of being developed on an industrial scale, wherever cheap power was available.

The "Mustikon" tube-repair motor-car outfit was shown at the stand occupied by "Fastnut," Limited, of 115, Newgate-street, E.C. It is claimed that with the apparatus and patches supplied repairs can be effected not merely much more expeditiously than by vulcanising, but with greater security all danger of injury to the tube being obviated. The repair is in the main made on the inside of the tube by means of special patches, which are, in fact, double patches connected together by a central stem or stud. In making a repair the



tube is cut to fit this stem, the patch is dipped into solution, pushed through the hole by means of special pincers provided for the purpose, and spread out flat on the inside, the condition being then as represented in the upper figure above. The outer table of the patch is then flattened down and cemented to the outside surface of the tube, as indicated in the second figure. The special patches are supplied in a variety of shapes and sizes suitable for making good either small nail-holes or tears 2 or 3 in. long. It is stated that the process has been used for months past on all the Allied fronts, the saving of time (repairs can be done at the roadside) and the permanence of the job being here, of course, of prime importance.

INDUSTRIAL NOTES.

A DEPUTATION representing the Parliamentary Committee of the Trade Union Congress and the Federation of Engineering and Shipbuilding Trades was received on Thursday, June 22, at the Board of Trade by Mr. Harcourt, who was accompanied by Dr. Addison, as representing the Ministry of Munitions. The two main points raised by the deputation related to the State control of food prices and the control of wages. The deputation consisted of members of the Parliamentary Committee and of the Executive of the Federation of Engineering and Shipbuilding, with two representatives from each District Committee of the Federation. In the course of his reply, Hr. Harcourt said that His Majesty's Government had given earnest attention to the financial position of the country, to the great and increasing demands which still will be made upon its resources to meet the needs of the war, and to the imperative need for economy in all forms of expenditure and consumption, both public and private. They had also had regard to the general advances of wages which had already been given since the beginning of the war, and to the measures already taken to tax or limit the profits of undertakings. His Majesty's Government had come to the conclusion that, in view of the present emergency, all further advance of wages (other than those advances following automatically from existing agreements) should be strictly confined to the adjustment of local conditions, where such adjustments were proved to be necessary. This was not intended to apply to the lowest paid men, whose wages it was agreed should be levelled up. It must, however, be recognised that all had to make sacrifices in consequence of the war, and that the vicious circle of, first, an increase of wages, then an increase in cost of production, and then an increase of prices, again leading to demands for further increases of wages, must be avoided. In war time we could not be allowed to exploit our individual advantages. Owners had been strictly limited by the Defence of the Realm Act and by the excess of profit tax and the limitation of profits under the Munitions of War Act. If there was an embargo on wages, there certainly was also an embargo on wealth. As regards wages, there had been a very general advance in rates of something like 10 per cent., but the advance of rates was no fair indication of the advance in earnings. In an actual case just brought before the Committee of Production, covering something like 5,000 men, it was shown that while the rate of wages had increased only 3s. a week, the average earnings of the men had increased by 19s. 6d. a week. Earnings rather than rates of wages must be looked at, and the increase of earnings could not be reckoned at 10 per cent., but would probably work out at nearer 40 per cent. This increase of earn.

ings was due to increased regularity of work, overtime, night work, and Sunday and holiday work, to transference of workers from the worst paid to the better paid occupations, and to other causes.

Speaking at a meeting of the National Union of Railwaymen at Bristol a few days ago, Mr. J. H. Thomas, M.P., outlined the situation of the railwaymen. He stated that in future all negotiations of a national character had to be conducted by the Executive, instead of each railway determining the particular conditions with varying methods in operation and an entire absence of uniformity as between one company's employees and another's. This change meant that the railways were to be treated as one unit and negotiations conducted for the railway workers as a whole. He hoped, therefore, that the railway companies and the members of the National Union of Railwaymen would immediately apply themselves to the necessary machinery to carry the change into effect. Mr. Thomas believed that the proposed new departure in negotiations could be accomplished, and that it would remove many difficulties. The industrial "triple alliance" of railwaymen, miners, and transport workers represented the majority of trade unionists, and if the alliance were rightly used it would be a power for good. It would be disastrous and ruinous if used unwisely. He did not look upon the alliance as a means of encouraging strikes.

Dealing with the unrest in the woolcombing trade, the *Textile Mercury* states that the need for some discipline severer than any that can be applied by the employers or the more sober-minded operatives has been growing more conspicuously apparent in the trade in question. The Union enters into solemn agreements and incontinently breaks them. Wages are raised, and instead of better work and more regular attendance the results are in every way worse. A call is made on the patriotism of the workpeople—a call that has been obeyed in apparently every other quarter in the land—and the call is ignored, although it is for nothing more than to allow women to do men's work at men's wages. In the case of the woolcombing trade, more wages were demanded, and a compromise was offered. A ballot was to be taken, but before the result could be known a large number of men struck work and toured the other sheds with the intention of intimidating others into not working. Great latitude has been allowed to a reckless set of men, and the outcome has not been beneficial. It is time to call a stop and to make plain to those concerned that there are higher authorities in this country than the National Society of Machine Woolcombers. Laws have been passed to provide against such defections as theirs, and the time has come to put them into operation. The men have had every chance of arranging their affairs peacefully, they are employed upon work arising out of Government contracts for cloth and knitted garments, and they must not be allowed to snap their fingers at the call for duty. Stern action is the only cure for the disorder of such products of 20 years' anarchical teachings.

We may add to the above note that the strike in the woolcombing trade directly affects about 15,000 operatives; the dispute also indirectly involves a large number of other operatives—spinners, woolsorters, warehousemen, &c.—and has for effect to hold up Government as well as private contracts. It is stated that several of the union leaders condemn the strike, and that many of the operatives on strike would willingly return to work were it not for the pickets sent out by the militant section of the unions involved. The strikers demand an increase in wages of 6s. per week. The owners offered an increase of 4s. and proposed that the matter be settled by arbitration by Sir George Askwith, but the operatives declined both points in the course of a meeting in which there was less than one-third of their number present.

A meeting of labour representatives of the Allied countries is to be held at Leeds on July 5 and 6. It is announced that the subjects to be considered are an international eight-hour day, a general Saturday half-holiday, the cessation of labour on Sundays, and an international approximation of laws relating to labour.

One of the most peculiar strikes that has occurred in New England for a long while took place, says *The Iron Age*, at the plant of the Fisk Rubber Company, Chicopee Falls, Mass. The employees of the heater department went out because of the dissatisfaction with the eight-hour day, which was one of the conditions of the settlement of labour troubles at the plant a few days ago. It appears that under the new straight eight-hour shifts the men were unable to earn as much as under the old conditions, when they were working a considerable number of hours overtime.

Representatives of the Amalgamated Association of America and of the sheet and tin-plate manufacturers opened a wage conference at Atlantic City, N.J., on Monday, June 12, says the same journal. An increase of from 10 to 15 per cent. is demanded by the men, while the employers declare they have already granted wage increases commensurate with the advance in the price of their products.

THE PHYSICAL SOCIETY OF LONDON.

At the meeting held on June 16, 1916, at the Imperial College of Science, Professor G. W. O. Howe, D.Sc., in the chair, a paper, entitled "*Experiments With Mercury Jet Interrupters*," was read by Captain C. E. S. Phillips. The paper describes an experimental attempt to ascertain the form of the mercury column issuing from a hole in the side of a rotating drum that is continuously supplied with mercury by centrifugal action.

Incidentally a new form of interrupter is introduced, in which the interior is visible through a window in the lid. The arrangement forms a suitable apparatus for experiments with various forms of orifices and metallic contact segments, and the paper gives an account of work in that direction. As it is important to ensure the cleanliness of the mercury in interrupters of this type, the usual copper segments are replaced by others made of tantalum, which, for many reasons, is preferable. It is not "wetted" by mercury, it remains clean and bright indefinitely, and its high melting point renders it lasting.

Experiments with various forms of orifice are described, and it is pointed out that the issuing stream is only slightly affected by this means. An explanation is given of the fact that a vertical slit orifice will not produce a ribbon of mercury, and that no matter how much the diameter of the orifice is increased beyond about 2 mm., the cross section of the mercury column remains unaltered. A method is described, however, by which a much larger stream of mercury can be obtained from the rotating drum, if necessary.

Brief reference is made to experiments with various volatile liquids in suppressing the flare which occurs when the mercury columns leave the contact segments. The three well-known substances which are most effective in this respect are coal gas, hydrogen and ether. It is pointed out that experiments of this nature are necessary, in view of the wide use now made of mercury interrupters in X-ray work.

Discussion.—Captain Reid thought the instrument described by the author was of considerable importance. In practice it would be a great advantage to see the interior of the instrument when anything went wrong.

Dr. R. S. Willows congratulated Captain Phillips on having broken new ground in his experiments. Mercury interrupters had not been very scientifically investigated so far. He thought experiments on the thickness and resistance of the jet, on the resistance at the contact with the tantalum vane, and on the effect of varying the inductance of the primary circuit on the performance of the interrupter, would yield results of importance. Had the best shape and inclination of the plate on which the jet impinged been worked out? With regard to the effect of different gases in quenching the flare, he thought the specific inductive capacities were the determining factor rather than the specific heats. The same problem was met with in running a singing arc.

Mr. G. L. Addenbrooke mentioned that one firm he knew of made interrupters with an electrode of variable inclination.

Captain Phillips, in reply, said that some of the points raised by Dr. Willows were dealt with more fully in the paper than in his description. The resistance of the jet was a very interesting point, and he had some experiments in progress on the matter. He was not quite clear whether the seat of the resistance was the mercury column or the junction of the column with the electrode. The position of the electrodes was also dealt with in the paper.

A paper entitled "*A Method of Measuring the Pressure of Light by Means of Thin Metal Foil*," Part II., was read by Mr. G. D. West.

The pressure of the radiation emitted by a carbon filament lamp, at a distance of a few centimetres, is sufficient to cause a microscopically measurable deflection of the end of a strip of gold or aluminium foil, suspended in a closed test tube. By this means the radiation pressure may be measured, and the results may be checked by a comparison with the energy density of the radiation, as deduced from the initial rate of rise of temperature of an exposed blackened copper plate.

In a previous paper, experiments were carried out in atmospheres of air and hydrogen, and at pressures extending from 76 cm. to 1 cm. of mercury. Under certain conditions it was found possible to obtain satisfactory results. The present paper deals with experiments at pressures from 1 cm. of mercury down to the highest exhaustions that could be reached. As the pressure is lowered, certain gas-action effects make their appearance, but, inasmuch as there is no appreciable difference of temperature on the two sides of the strip, the effects are somewhat different from those that occur in the ordinary type of Crookes' radiometer.

When the surface of the strip is closer to one side of the containing vessel than to the opposite side, a deflection away from the closer side occurs, and the direction of this deflection is independent of the side of the strip, on which the radiation falls. With a symmetrically-placed strip the deflection should be negligibly small. An explanation of these effects is suggested in the paper, and a special type of radiometer is described.

The nature of the residual gas in the tube does not seem to be very important, but it is found that the repulsive force acting on the strip increases with decreasing pressure, until a maximum is reached at about 0.002 cm. of mercury. With further reduction of pressure a progressive decrease takes place. By symmetrical suspension, and by the use of liquid air and charcoal, it is possible so to reduce the gas action effect that measurements of the pressure of light of reasonable accuracy are again possible. Experiments on the pressure of light may thus be advantageously carried out at the highest vacua obtainable, or at pressures as far above 0.002 cm. of mercury as convection currents will permit. The latter alternative is the easier, and leads to more consistent results.

A paper entitled "*The Viscosity of Suspensions of Rigid Particles at Different Rates of Shear*," by Edith Humphrey, B.Sc., Ph.D., and Emil Hatschek, was read by the former.

This investigation was undertaken with a view to testing the Einstein-Hatschek formula at variable rates of shear. According to this formula the viscosity of a suspension of rigid spherical particles grows in linear ratio with the aggregate volume of suspended particles, and is independent of their size as long as the latter conforms to Stokes's formula. The suspension chosen was one of rice starch of 0.003 mm., and less, diameter, in a mixture of carbon tetrachloride and toluene having the same specific gravity. The measurements were carried out in a modification of Couette's apparatus, in which the deflection of a cylinder, suspended coaxially in another cylinder filled with the liquid and rotated at different speeds, is measured. All measurements were carried out at speeds below that at which turbulence sets in, so that the deflection was proportional to the product of viscosity × angular velocity.

The results of the investigation are: (1) The viscosity of a suspension is a function of the rate of shear, and increases as the latter decreases, the difference being more marked at higher concentrations; (2) for all rates of shear the viscosity of the suspension increases more rapidly than the aggregate volume of suspended matter; (3) for any one rate of shear the relative viscosity of a suspension, *i.e.*, its absolute viscosity divided by the absolute viscosity of the medium at the same rate of shear, also increases more rapidly than the percentage of suspended matter the divergence from the linear increase demanded by the formula becoming less as the rate of shear becomes greater, so that a linear law may possibly hold good at rates of shear higher than those attainable in the present apparatus without turbulence.

The general conclusion is that the assumption on which the Einstein-Hatschek formula is based, viz., non-interference between adjoining particles, is not tenable in the case of suspensions containing between 2 and 6 per cent. of suspended matter.

A paper entitled "*A Correction of Some Work on Diffusion by Dr. A. Griffiths and Others*," by Dr. A. Griffiths, was taken as read on account of the lateness of the hour.

When salt diffuses through water, in general there must be a movement of the water due to volume-changes associated with variations in concentration. In the papers to which the recalculation refers reference was made to the velocity of the liquid or solution; but what was meant by the velocity of the liquid was not explained. The author now deals with the velocity of the water-component of the solution, to which a clear mathematical meaning can be given. When salt leaves a given section of the vessel containing the solution, the diminution in volume of the contained liquid is prevented by the automatic addition of water, and of water only. In the papers to which the recalculation refers, the error was made of assuming that the diminution of volume was prevented by the automatic addition of solution. The results by the method of diffusive convection require no recalculation, and agree with Mr. Clack's recalculated values to less than 1 per cent. There is no doubt that the results, as recalculated, given by the three methods employed in the author's laboratory agree within the limits of experimental error; and the author's opinion is that the true value of the co-efficient of diffusion lies close to those given by his convective method and by Mr. Clack's gravitational method.

RECORD IN BLAST-FURNACE CONSTRUCTION.—On Monday, June 5, No. 9 blast-furnace of the Cambria Steel Company, Johnstown, Pa., was put in blast, and it is believed, says *The Iron Age*, that the time in which it was erected breaks all records in the construction of a large blast-furnace. The building of the furnace was authorised on March 6 last. The general lay-out was approved on March 9, and a site was selected and active work on the foundations started on March 12. Before the foundations were started it was necessary to clear the site, which took up some little time. In just 85 days from the time the stack was authorised, it was completed and put in blast.

WIRELESS AT THE ANTIPODES.—A wireless station was opened recently at the Chatham Islands connecting that group with the mainland of New Zealand and extending the range of communication eastward. The apparatus is Telefunken, of 2½ kw. primary power, with storage battery. The prime mover is an oil engine. The aerial is of the T type, suspended at a height of 150 ft. from two tubular steel structures 300 ft. apart; an earthed counterpoise completes the aerial equipment. The normal range of this 2½-kw. station is 300 miles by day and 600 miles by night. High-power stations at Awanui and Awarua have been opened for public business. The stations are of 30-kw. primary power and have been undertaken principally for defence purposes. They communicate with Sydney during the day as well as at night. The aerials are suspended from towers 394 ft. in height, and the wires spread from the summit and base of the towers over an area of 90 acres.

ALLOTROPIC CHANGES IN IRON OR OTHER METALS.

*A New Thermo-Electric Method of Studying Allotropic Changes in Iron or Other Metals.**

By Professor CARL BENEDICKS, Fil.D. (Physical Laboratory of the University of Stockholm).

Introductory.—In a closed circuit, consisting of a homogeneous metal, no electromotive force, capable of causing a current, is produced, howsoever the temperature of any part may be changed, according to Magnus. If, however, the metal has an allotropic transition point (two-phase point), and some part of the circuit be heated, and remain at a stationary temperature above this point, the circuit can no longer be said to be homogeneous, as the hottest part, according to the assumption, corresponds with a new allotropic state—forming a new phase. However, even in this case, no electromotive force comes into play, as the differences of potential, which *a priori* may be assumed to exist between the two phases, equalise each other at the contact surfaces, on account of the equality of temperature of the contact surfaces. If, on the contrary, the local heating be not stationary, there is always a possibility that the two contact surfaces may differ in temperature. Let us assume, as a special case, that the locally heated zone might travel with a constant speed along the conductor. Now it is known that the temperature of a given transition is always somewhat higher on heating than on cooling, which depends on the fact that a real allotropic transformation takes a definite time to perform in every case. Thus the contact surfaces between the two phases, as already stated, will have slightly different temperatures, and there is a possibility that a measurable thermo-electric force will come into action. In fact, it was stated by F. T. Trouton,† as early as 1886, that a thermo-electric current is produced when an iron wire is moved through a flame, so that probably a local heating above 900 deg. may occur. This phenomenon, which, though simple, affords a good lecture experiment,‡ was correctly explained by G. F. FitzGerald as depending on what Sir W. F. Barrett,§ in an interesting note, describes as thermo-electric hysteresis.

In near relation to this effect an observation made shortly before by H. Le Chatelier‖ on silver iodide bears closely on the same point. The substance was enclosed between two metal electrodes, the circuit thus consisting of two different conductors. It was found that at the transition point strong electromotive forces appeared, which primarily were to be ascribed to a thermo-electric action. It was proposed by Le Chatelier to take advantage of this phenomenon for the study of allotropic transformations. At his suggestion, O. Boudouard¶ made some determinations on nickel steel. Le Chatelier** himself published some curves for special steels obtained by this method (platinum wires were fixed at the ends of a short steel specimen, and the electromotive force between them was observed on ordinary heating or cooling). This method, however, has not been generally accepted, probably on account of a serious inconvenience already pointed out by Le Chatelier. In fact, the electromotive forces which come into play with this arrangement (immovable, bimetallic specimen) are occasioned by the inevitable, totally uncontrolled local temperature variations of the furnace, with the consequence that even "the direction of the current observed at the very moment of transition may change with each experiment."†† Thus, if the temperature degree of a transition point can be determined by this method, every quantitative conclusion as to the intensity of the transformation seems to be excluded.

It might now be asked whether it is not possible to overcome this inconvenience and to find a quantitative method, if, according to the foregoing explanation, *a local heating, travelling with uniform speed along a wire*, is made use of. It has occurred to the author, first, that this might furnish a quantitative method for ascertaining the existence of allotropic points in the metal (two-phase allotropy); further, that this method might possibly give useful information even in the case of an inner molecular equilibrium, changing with temperature (one-phase allotropy). In fact, the molecular changes even in this case probably take some definite time to occur, and the equilibrium, at a given temperature, ought not to be quite identical on heating and on cooling; thus generally a thermo-electromotive force should come into play, even though only single phase is present. Since, according to the theory advanced by the author,* and lately treated in a careful way by K. Honda,† such a one-phase allotropy interval exists below the two-phase point A3, it seems to be of special interest to study iron by this method, especially at the temperature interval below A3.

Experimental Arrangement.—According to the principles explained above, the experimental arrangement was a very simple one (Fig. 1), as follows:—

The metal wire AA′ to be studied moves through a little electric furnace B, the maximum temperature of which is measured by a platinum platinum-rhodium thermo-couple, with a compensating arrangement C (St. Lindeck and R. Rothe). The free ends of AA′, at F (constant temperature), are connected with the copper wires leading to a mirror galvanometer G.

The central part of the wire, AA′, is stretched by two strings, running over a horizontal wheel E and two small vertical pulleys H, H′, and loaded with the weights P, P′. A uniform motion is communicated to AA′ in the one or the other direction by a third string, which is wound on a cylindrical drum by the clock-work J (gramophone movement); by suitable guides I is easily brought into line with the string at H or at H′.

The wire AA′ was sufficiently protected against oxidation by passing it through a fixed silica capillary tube D.

The furnace being heated to a suitable temperature, the deviations of the galvanometer G were read with AA′ moving first in one and then in the other direction. The half of this difference in millimetres is given as the deviation U.

The sensibility of the galvanometer (resistance about 100 ohms) was such that 1 mm. corresponded with 5.6×10^{-6} volts.

The value of the electromotive force resulting must be influenced by several factors, not taking into account the nature of the material itself and the temperature, namely (1) the speed of displacement, (2) the section of the specimen, and (3) the temperature distribution in the furnace.

1. Smaller variations in the speed of displacement were found to have very little influence, except for the purest iron. A constant speed of 1.6 mm. per second was adopted throughout.

2. The diameter of the wire especially investigated was 1.01 mm. Owing to this thickness a load P, P′, amounting to 125 grammes, could be used, which was enough to secure a very uniform displacement of the wire.

As will be seen from Series I. and II. on the one hand, and III. on the other, the influence of the diameter of the wire is probably very slight.

3. In order to obtain an idea of the temperature distribution of the heated zone through which the wire had to pass, the mean of the observations of the temperature T at different distances X from the middle of the furnace is given as follows:—

Distance X. Millimetres.	Temperature T. Degrees Centigrade.
+ 50	300
40	587
30	797
20	848
+ 10	857
00	858
− 10	859
− 20	837
30	710
40	410
− 50	255

This distribution is graphically shown in Fig. 2.

Material Used.—The iron selected for investigation was obtained in April, 1912, from the Kohlswa Ironworks. It contains 0.10 per cent. of carbon, but is otherwise of a remarkable purity, as shown by the following analysis, performed at the Kohlswa laboratory:—

Carbon.	Silicon.	Manganese.	Phosphorus.	Sulphur.
0.10	0.014	0.03	0.026	0.007

Delivered as rolled wire 5.2 mm. in diameter, it was further drawn down to the diameter mentioned of 1.01 mm. at the wire-works of the Nya Garphytte Fabriks Aktiebolag, Latorps Bruk.

Since for the special control Series III. a thinner wire was desirable, the author drew the wire further, in an ordinary drawing-plate. On this occasion the—as it seems to him—very interesting observation was made, that this material—obviously on account of its great purity—could be directly drawn through the finest hole of the plate, 0.23 mm., and further in sapphire holes to 0.09 mm., *without the slightest annealing*, and without any real hardness being produced by this severe cold-working. This fact seems to prove that iron of a high state of purity, even at 0.10 per cent. carbon, has considerably more "liquid inner friction," and considerably less "solid inner friction,"* than has been generally believed—even in view of the extremely high mechanical deformability of pure iron in A 3, found by the author two years ago.†

It can be questioned whether this extremely high softness‡ of pure low-carbon iron is favourable to the well-known Beilby hard amorphous state theory.

Since it was highly desirable to make determinations, by the method now described, on still purer iron wire, which was, however, not available, the following method was tried and found to be practicable. A small thin specimen of the extremely pure electrolytic iron used by Doctors J. E. Stead and H. C. H. Carpenter,§ kindly presented by Professor Carpenter, was carefully rounded off at the corners, after which a strip, about 1.3 mm. broad and of sufficient length, was cut off round the piece. This strip was straightened, and strengthened—especially against oxidation—by forming it into a U-section.

Experimental Results.—Determinations at a given temperature, as was to be expected, showed no difference when made during heating or cooling of the furnace.

A blank experiment was performed with a 1-mm. copper wire in the same interval of temperature as that finally used. After a first annealing, no deviation of the galvanometer whatever was obtained, which agrees

Fig. 1. ARRANGEMENT OF EXPERIMENTAL APPARATUS.

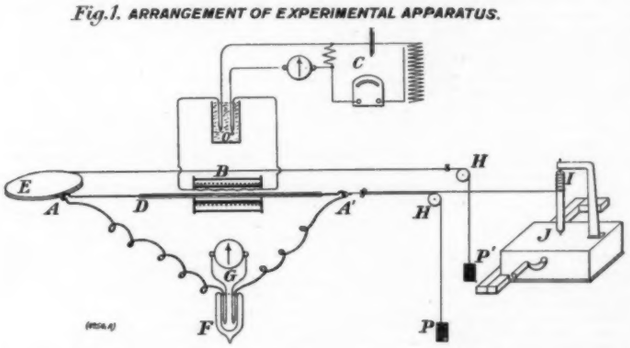


Fig. 2.

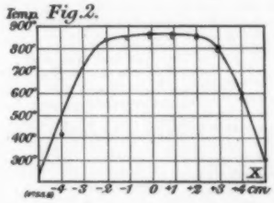
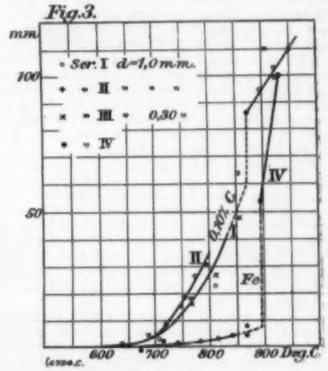


Fig. 3.



* Paper taken as read at the meeting of the Iron and Steel Institute, May, 1916.

† Proceedings of the Royal Dublin Society, 1887, vol. v.

‡ The flame, which may possibly cause some chemical alteration, can then be conveniently replaced by a small electric heating device.

§ Transactions of the Royal Dublin Society, 1900 (2), vol. vii., page 127; Philosophical Magazine, 1900 (5), vol. xlix., page 309.

‖ *Comptes Rendus*, 1886, vol. cii., page 917.

¶ *Revue de Métallurgie*, 1904, vol. i., page 80.

** *Ibid.*, page 134.

†† *Ibid.*, page 138.

* Journal of the Iron and Steel Institute, 1912, No. II., page 242; 1914, No. I., page 407.

† *Ibid.*, 1915, No. I., page 199; Sci. Reports of the Tohoku Imperial University, 1915, vol. iv., page 169.

* *Cf.* H. I. Hannover, Mekanisk Teknologi, II., 3 Ed., Copenhagen, 1915, footnote, page 68.

† Journal of the Iron and Steel Institute, 1914, No. I., page 431.

‡ In this connection it might be pointed out how important it is that laboratories, equipped with good technical mechanical appliances, should be at the disposal of scientific men, offering the possibility of autoptic observations. Exactly the same 1-mm. iron wire, on the request of Dr. Bengt Beckman, Upsala, was sent by me to the Cryogene Laboratory, of Leyden, where it was to be used for researches by Professor H. Kamerling Onnes and Dr. Beckman. This wire was drawn by Heraeus in Hanau to a diameter of 0.1 mm. If, in Hanau, some observations were made of the very peculiar viscosity properties of this iron, they apparently have not been reported to these authors (Comm. Phys. Labor., Leyden, No. 132, page 7, 1913). At the Garphytte Works, the manager, Mr. G. Tidholm, found that this iron was so excellent for drawing purposes that inquiries were made as to whether it could be obtained in commercial quantities. It was only after having gained personal experience in the fine drawing of this material that the author could get some idea of this remarkable occurrence of "liquid inner friction" in iron, which, according to a private communication, was likewise unknown to Professor Hannover, to whom a sample was sent.

§ Journal of the Iron and Steel Institute, 1913, No. II., page 119.

with the known absence of allotropic change in this metal.

The result of the first series (I.) of experiments on the Kohlswa iron wire is given in the following table :—

Temperature T. Degrees Centigrade.	Deviation U in Millimetres.	Mean.
642	+ 1.9	
	− 0.3	1.1
708	5.1	
	1.2	3.2
755	18.7	
	18.5	18.6
810	21.2	
	23.4	22.3
854	64	
	61	63
873	84	
	88	86
898	—	94
925	99	
	102	100.5
950	—	110

These determinations are reproduced graphically in Fig. 3 as small circles.

It will be seen that this thermo-electric hysteresis effect is already sensible somewhat above 600 deg.; other determinations not given here seem to corroborate this lower limit, though in a somewhat uncertain manner. The effect increases with increasing velocity, as it seems, up to about 875 deg., where an increase at constant rate sets in, corresponding with the γ-range. It may be said that A3 is clearly shown by a discontinuity.

This first series, however, is not sufficiently accurate to enable it to be decided whether, between 600 deg. and 875 deg., the increase is a continuous one, or whether there might be a discontinuity at A2 (768 deg.). A second series (II.) was carried out between 700 deg. and 800 deg., marked by vertical crosses. The observed values do not show any discontinuity.

A third series (III.) was performed on the same material, drawn out to 0.30 mm. wire. Owing to the fact that the stretching weights were only 20 grammes the motion was less regular than before. It will be seen, however, that the observed points (diagonal crosses) do not differ much from previous observations. This indicates that the slight oxidation which occurred has no sensible effect on the observations, which also seems probable from other points of view, and that the diameter has but a slight influence.

A fourth series (IV.) was executed on the strip of pure electrolytical iron, as mentioned above (shown by full circles). In this case, as might be expected from the known influence of impurities, the effect is generally much less strong than with the 0.10 per cent. carbon iron; the difference is less pronounced at the highest temperature, where, of course, the γ-state prevails even in the absence of every trace of impurity. In any case, in a qualitative way, the effect is the same.

It was rather interesting to find, consistently with the impurity effect just mentioned, that, whilst for the iron with 0.10 per cent. carbon the speed of the motion had but very little influence, for the purest iron the effect was stronger if the speed exceeded the normal value.

The total appearance of the curves is similar to the well-known dilatation curves (Charpy and Grenet), inasmuch as both obviously belong to the allotropy type IIa. The new determinations have the special interest of proving the existence of molecular changes, demanding a definite time to occur.

It is scarcely necessary to point out that these new facts give additional support to the theory expounded by the author, that a continuous molecular change does occur in the α-phase at temperatures up to A3, or, in other words, that the α-phase has an increasing solubility for the molecules, or atoms, which are to be considered as characteristic for the γ-phase. Whereas A3 is a true allotropic point, where two phases co-exist, this is not the case with A2. On the other hand (and this might be the principal result), it has been found that a local heating, travelling with definite speed, constitutes a method which may be of value for allotropy investigations, not only for iron, but for other metals or alloys as well.

As for iron, it would be highly desirable to use pure iron wire, of sufficient length and diameter, and to repeat the determinations with greater accuracy, and with greater velocity, than it was possible to do here, on account of want of material.

Summary.—The principle is described and an experimental arrangement is shown for a method of determining an effect of thermo-electrical hysteresis (Barrett) in metals, which are characterised by allotropy (both two-phase and single-phase). The metal to be investigated is moved, in the form of a wire, with constant speed through a small furnace, the maximum temperature T of which is known; between the free ends of the wire an electromotive force may appear, if molecular changes occur in the metal at temperatures below T.

2. It has been found that this thermo-electric hysteresis effect, for iron, shows a very marked discontinuity at A3 (Fig. 3). Above this point the effect is very strong, following a straight line, but it is also very considerable at lower temperatures, even as low as about 600 deg.

As might be expected, the effect is considerably stronger in iron with 0.10 per cent. carbon than in carbonless iron.

No discontinuity corresponding to A2 could be found.

3. These experimental results give additional support to the theory of the allotropy of iron, as expounded by the author. However, their accuracy is not very high, and it is desirable that they should be repeated, especially on homogeneous solid wire of purest iron.

The author has the pleasure of acknowledging his indebtedness to Mr. L. U. Lindberg, Kohlswa, for the valuable specially selected research material, and to Mr. G. Tidholm, Garphyttan, for his kindness in drawing the wire.

COLONIAL AND FOREIGN ENGINEERING PROJECTS.

We give below a few data on several colonial and foreign engineering projects taken from the *Board of Trade Journal*. Further information on these projects can be obtained from the Commercial Intelligence Branch, Board of Trade, 73, Basinghall-street, London, E.C.

Australia.—The Sydney Office of H.M. Trade Commissioner for Australia reports that the Estimates submitted by the Commonwealth Treasurer to the House of Representatives include the following votes for additional works to be carried out, mostly in New South Wales:—Sydney Customs House, 5,000*l.* (the total estimated cost of this undertaking is 30,000*l.*); Spectacle Island Naval Establishment, 6,204*l.*; Jervis Bay Naval College, 30,000*l.*; Lithgow Small Arms Factory, 30,800*l.*; Canberra Arsenal, 20,000*l.*; Post Office, Stores and Telephone Exchange in Sydney, 7,676*l.*; and Cockatoo Island Dockyard, 100,000*l.*

Brazil.—H.M. Consul at Porto Alegre reports that the Directorate of Public Works of the State of Rio Grande do Sul has called for tenders for the construction of quays at the port of Porto Alegre. 600 metres of quay wall are to be built, the cost of which is calculated by the Directorate of Public Works at 1,534,158 milreis (about 78,800*l.*). H.M. Consul observes that although it is impossible for United Kingdom firms to compete, owing to the limited time allowed for the receipt of tenders, namely, up to June 23, it may be possible that United Kingdom firms might be able to supply some of the material, such as *cement*, to the successful tenderers.

Argentina.—With reference to the progress of the Rio Neuquen and Rio Negro irrigation works, H.M. Minister at Buenos Aires reports that a supplementary contract has been signed authorising the Great Southern Railway Company to expend a further 270,000*l.* for the completion of the work in hand. The rate of expenditure is not to exceed 87,000*l.* a year.

AUSTRALIAN BORDER RAILWAYS.—A Royal Commission is inquiring into certain border railway proposals affecting Victoria and New South Wales. The Commission has eight separate proposals under review, and is empowered, if it so desire, to recommend the adoption of any three. The idea is to allow of the construction of lines from the Victorian side into New South Wales for a distance of, say, 40 miles, so as to permit of the trade of an immense area of land at present unserved by the New South Wales railway system, and far removed from the existing termini, being diverted to Melbourne, which is some 300 or 400 miles nearer than Sydney. It is proposed that the lines be built on the Victorian gauge so as to render transhipment unnecessary, and that the construction be carried out by the New South Wales Government, the Victorian Government to guarantee interest and to make certain other payments should profits permit. The construction of a bridge across the Murray River at Corowa is also proposed at a cost of 60,000*l.* or 70,000*l.*, Victoria to bear two-thirds of the expenditure and New South Wales the balance. The scheme also makes provision for the irrigation of the land affected where possible under the terms of the Murray River Waters Agreement. It is understood that the lowest cost of any scheme which the Commission may choose to recommend will exceed 1,000,000*l.*

THE UNITED STATES NAVY.—The Appropriation Bill for 1917 of the Naval Committee of the United States Congress, as reported to the House of Representatives, amounts to 241,449,151 dols., or 91,000,000 dols. in excess of the corresponding appropriation for 1916. The construction programme authorised by the Bill provides for the building of 5 battle cruisers, 4 scout cruisers, 10 destroyers, 3 fleet submarines, 17 coast submarines, 1 fuel ship, 1 ammunition ship, and 1 hospital ship. The cruisers are intended to be the most powerful vessels of their class afloat, and they will cost 20,400,000 dols. each, so that they alone absorb 102,000,000 dols. This expenditure is to be spread over a period of three years, so that the actual expenditure of each year will be 33,800,000 dols. or thereabouts. It is proposed to increase the *personnel* of the American Navy by 16,579 enlisted men, of whom 3,079 are intended for the marine corps. A large increase is made in the appropriation for munitions, the amount set apart under this head being 13,700,000 dols. The construction of dry docks is proposed at the Philadelphia and Norfolk navy yards, and 2,000,000 dols. is set apart for the purchase of aviation machines and motors. A naval flying corps, consisting of 150 officers and 350 enlisted men, is one of the proposals made by the Committee, and the purchase of an aviation base at San Diego is authorised. A Minority Committee has drawn up a report urging that 2 Dreadnoughts and 6 battle cruisers should be provided, with a greatly increased number of submarines—50 instead of 20. It is also suggested that the *personnel* of the navy should be further increased by 31,000 more men.

CATALOGUES.

Lightning-Arresters.—A price-list recently received from the British Thomson-Houston Company, Limited, of Rugby, gives particulars of lightning-arresters for use on continuous-current circuits. These arresters consist of a single spark-gap in series with a non-inductive resistance and protected by means of a magnetic blow-out. The lightning discharge passes directly through the spark-gap and resistance to earth, and, if any current from the supply system should follow the lightning discharge and tend to maintain the arc, part of this current will pass through the blow-out coil, which is connected in parallel with the gap, and so produce a strong magnetic field which blows out the arc. The spark-gap terminals are screwed for the whole of their lengths, so that they are firmly held, but at the same time the length of the gap can easily be adjusted. The working parts are all enclosed in a box of brown-glazed porcelain, to the lid of which the spark-gap terminals are attached so that they are easily accessible for cleaning and adjusting when the lid is removed. Prices are stated for arresters and accessories suitable for station and line use on circuits ranging from 60 to 850 volts; shipping specifications are also given.

Valves and Cocks, Boiler Mountings, &c.—A set of four sectional catalogues giving full particulars of their products has come to hand from Messrs. Alex. Turnbull and Company, Limited, of St. Mungo Works, Bishopbriggs, Glasgow. One of the sections deals with "Turval" safety valves for stationary, locomotive, and marine boilers, and includes valves of the deadweight and spring-loaded types, as well as valves with high and low-water alarms; spring-loaded relief valves and safety valves of the weighted-lever type are also included in this section. The next section relates to globe and junction stop valves, which the firm make to standard and special designs for all pressures and conditions. Valves with iron or steel bodies are listed in sizes ranging from 1¼ in. to 12 in. in diameter, and bronze valves from ¼ in. to 3 in. in diameter. Full-bore parallel-slide valves for high-pressure steam, sluice valves for steam and water, steam-main isolating valves, expansion joints, and steam-traps, are dealt with in another section, while the remaining section is devoted to feed-valves, check-valves, blow-off valves, asbestos-packed cocks, isolating valves, water-gauges, pressure-gauges, steam-whistles and syrens, plug-cocks, try-cocks, &c. Specifications and dimensions are given in all cases, and prices are also stated, so that the catalogues will be of great utility to all steam-users; they are well printed and very fully illustrated.

Electric Hammer Drill.—A bulletin recently issued by the Chicago Pneumatic Tool Company, of Fisher Building, Chicago, Ills., U.S.A., relates to the Duntley portable electric hammer drill. These tools, which are suitable for drilling holes up to 1 in. in diameter in stone or concrete, and also for light chipping, are operated by a small electric motor, which runs equally well on either continuous or single-phase current. The hammer blow is delivered on to the drilling-bit, or chisel, by a piston operated by pneumatic power from the motor, which is controlled by a thumb-switch on the handle of the tool. Ball-bearings are used throughout for the rotating parts, and provision is made for the thorough lubrication of all moving parts. A special feature of the tool is the use of compressed air for blowing dust and chippings out of the hole during the process of drilling. For this purpose the drilling-bits are made hollow, and the air is delivered through them close to the cutting edges. This arrangement not only ensures the full force of the blow being delivered directly on to the stone or concrete, but also enables the drilling-bit to be easily withdrawn, when the hole is finished, by removing the chippings, which might otherwise cause it to jam. The weight of the tool is 21 lb., and its over-all length is 17½ in. The London address of the firm is the Consolidated Pneumatic Tool Company, Limited, 9, Bridge Street, Westminster, S.W.

INDIAN RAILWAY ADMINISTRATION.—The broad-gauge (5½ ft.) system of the Bombay, Baroda and Central India Railway comprises 1001¼ miles of line, of which 257 miles are laid with a double track. The metre-gauge system comprises 1827½ miles, of which 26½ miles are mixed gauge; and the 2½-ft. gauge 29½ miles. Altogether the company's network thus embraces 2859 miles of line. In addition to this mileage the company works 868¾ miles of line for native States or companies, making a final aggregate of 3727½ miles. The ratio of the working expenses upon the combined system during the half-year ended September, 1915, was 53.46 per cent., as compared with 54.14 per cent. in the corresponding period of 1914. The distance run by trains on the broad-gauge system in the six months ended September, 1915, was 3,073,973 miles, as compared with 3,134,028 miles in 1914; and upon the metre-gauge lines, 3,826,043 miles, as compared with 3,134,028 miles. At the close of September, 1915, the company owned 357 broad-gauge locomotives and 492 metre-gauge engines. The number of coaching vehicles upon the combined system was 2796, and the number of goods vehicles 18,247. In the six months ended September, 1915, there was a large increase in the gross earnings, with a considerable diminution in working expenses. This was largely due to a curtailment of renewals and to economies effected in compliance with injunctions from the Indian Government and necessitated by the war. This curtailment, being mainly a suspension of necessary renewals, will, of course, reduce future net earnings. The dividend upon the capital stock of the company for 1915–16 is at the rate of 5 per cent. per annum. This compares with a return of 4½ per cent. for 1914–15 and 4¾ per cent. for 1913–14.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

SELECTED ABSTRACTS OF RECENT PUBLISHED SPECIFICATIONS UNDER THE ACT OF 1907.

The number of views given in the Specification Drawings is stated in each case; where none is mentioned the Specification is not illustrated.

Where inventions are communicated from abroad, the Names, &c., of the Communicators are given in italics.

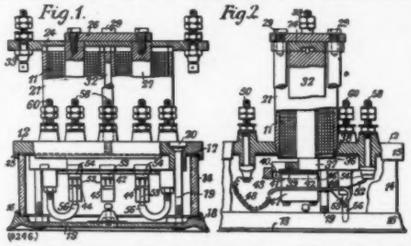
Copies of Specifications may be obtained at the Patent Office, Sales Branch, 25, Southampton Buildings, Chancery-lane, W.C., at the uniform price of 6d.

The date of the advertisement of the acceptance of a Complete Specification is, in each case, given after the abstract, unless the Patent has been sealed, when the word "Sealed" is appended.

Any person may, at any time within two months from the date of the advertisement of the acceptance of a Complete Specification, give notice at the Patent Office of opposition to the grant of a Patent on any of the grounds mentioned in the Act.

ELECTRICAL APPARATUS.

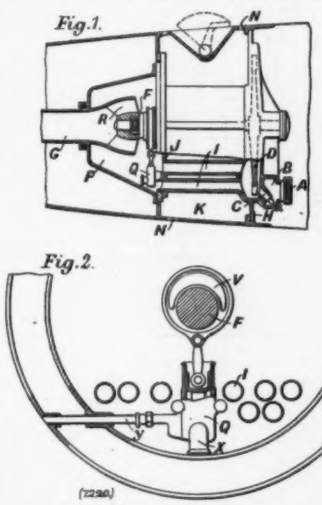
9246/15. W. R. Sykes Interlocking Signal Company, Limited, and G. H. Sykes, London. Electric Relay. [4 *Figs.*] June 23, 1915.—This invention relates to electric relays (such as are used, for example, in connection with railway track-circuits for the control of signals) of the type comprising a pair of upright electro-magnet coils mounted upon a flanged plate constituting a closure for the top of the casing which encloses the relay armature, switches, and contacts; the bottom of the casing, consisting of a second flanged plate, which serves as a base for the relay as a whole, and the wall of the casing being formed by a length of cylindrical glass tubing, whose upper and lower ends are jointed by means of rubber washers or gaskets to the top and bottom plates, which are usually drawn towards one another by screws passing through the interior of the casing and sealed into one of the plates. According to this invention, the plate or disc of insulating material constituting the top of the casing which encloses the relay-armature, switches, and contacts, and whereon the relay-coils are mounted, is moulded integrally with all such projections, recesses, apertures, and other features as are required in order to permit of the relay-coils and the various contacts, terminals, and binding-posts being directly positioned upon and firmly secured to said top disc without the necessity of any special fitting or further preparation of the disc itself. The electro-magnet coils 11, 11 of the relay are mounted upon the top disc 12 of the relay-casing, this disc 12 being formed of moulded fibre or equivalent insulating material. The bottom disc 13 of the casing is a metal casting, whilst the side wall 14 of the casing is constituted by a length of glass tubing interposed between the discs 12 and 13, and kept in place relatively thereto by flanges 15 and 16 on the respective discs; gaskets 17 and 18 of india-rubber being employed to seal the joints at the upper and lower ends of the tube. The top disc 12 is drawn downwards, so as to close these joints and hold the parts of the casing securely together, by means of a pair of screws 19, 19 which pass through holes in the disc 12 and engage in tapped holes in the disc 13, the head of each screw being countersunk in the top disc so as to leave a recess 20 (Fig. 1) for securing the screw by a seal. Each coil 11 is enclosed in a cylindrical sheath 21 of insulating material, whose lower end (in the example illustrated) is tapered externally to fit tightly in a correspondingly tapered hole in the top disc 12; the sheaths 21 thus forming, in effect, hollow pillars within which the coils 11 are suspended. The upper ends of both sheaths are closed by a single cover-plate 24 of moulded insu-



lating material recessed to fit over the sheaths, whilst this cover-plate 24 is surmounted by an iron plate 26, constituting the yoke of the electro-magnet whose cores 27, 27 pass through holes in the cover-plate 24 and are drawn up tightly into contact with the yoke 26 by screws which pass through holes in the yoke and enter tapped holes in the upper end of the cores. The yoke 26 also serves as a washer-plate for keeping the cover-plate 24, coils 11, cores 27, and attached parts in place, for which purpose screws 29, 29, passing through holes in the yoke 26 and bearing by their heads on its upper surface, enter tapped holes in the upper ends of a pair of vertical posts whose lower ends are screwed into the top disc 12; the screws 29 drawing the plate 26 tightly down upon the tops of the posts, which thus act as distance-pieces. In the example illustrated, the axes of the posts 30 lie in a plane which extends at right angles to the plane wherein lie the axes of the coils 11. In order to steady the sheaths and render the structure rigid, a moulded distance-block 32 of insulating material, having concave sides to fit snugly against the cylindrical peripheries of both sheaths, is inserted between the latter so as to extend from the cover-plate 24 to the top disc 12. The ends of the cover-plate 24 are extended to form brackets for the support of the binding-posts 33, 33 of the outside leads for the coils 11, 11; the upper ends of the sheath 21 and of the distance-block 32 being notched to give passage to the wires which connect the coils together and which couple each coil to the lower end of the corresponding binding-post. Each binding-post 33 passes vertically through a hole in the cover-plate 24, and is provided above the latter with the usual binding-nuts. The lower end of each sheath 21 is closed by a disc 36 of insulating material which rests upon a shoulder presented by an enlargement 37 at the lower end of the corresponding magnet-core 27. 38 is a brass ring which is wedged on the reduced lower end of each sheath so as to prevent splitting. The enlargements 37 of the lower ends of the cores constitute pole-pieces, and are formed on one side with flats, to which is fixed, by screws, a bar 39 having at its ends brackets, to which are pivoted, at a common axis 40, a pair of arms 41 supporting the armature 42. As the latter tends to fall away from the pole-pieces 37 under gravity, a counterweight 43 is provided upon rearward extensions of the arms 41, so as to reduce the effort required to raise the armature and parts carried thereby. To the underside of the armature 42 are attached three switches 44, 45, 44, whereof the switch 45 occupies a central position, whilst the two others 44, 44 are equidistant therefrom towards the respective ends of the armature. The switches, which (except as regards one feature) are all of the same construction and dimensions, extend transversely of the armature 42, each switch being insulated from the others and from the armature by being held between blocks 46, 47 of insulating material. The rear end of each switch is permanently connected by a flexible conductive strip 48 to one of a row of terminals depending from the top disc 12 at the same side of the armature, each terminal being on the lower end of a binding-post 50, which extends through an aperture in the disc 12 and is clamped to the latter and provided above the disc with the usual binding-nuts. The front or free ends of the switches 44, 45, 44 carry light spring brushes 52 respectively adapted, on the armature being raised when the relay is energised, to establish electrical connection with upper contacts (preferably of carbon) 54, 55, 54; whilst the two outer switches 44 carry also similar spring brushes 53 respectively adapted, when the armature drops on the relay ceasing to be energised, and after the corresponding brushes 52 have left the contacts 54, to establish electrical connection with lower contacts 56. The front end of each switch 44 is bent to form a stop for preventing excessive straining of the corresponding switch-brush 53, when the latter, in falling, meets its lower contact 56. The upper contacts 54, 55, 54 depend in a row from the top disc 12 at the front side of the armature, each contact being on the lower end of a binding-post 58 which extends through an aperture in the disc and is clamped to the latter and provided above the disc with the usual binding-nuts. Each of the lower contacts 56 is presented by the upwardly-reverted end of a binding-post 60 which extends through an aperture in the top disc 12 and is clamped to the latter. (*Sealed.*)

GUNS AND EXPLOSIVES.

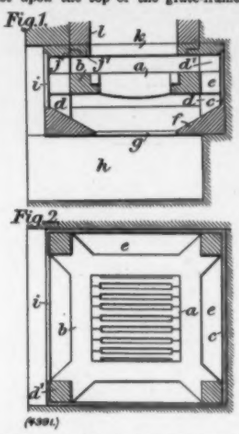
7220/15. Societe Anonyme des Etablissements Delaunay-Belleville, St. Denis, France. Self-Propelled Torpedoes. [4 *Figs.*] June 30, 1914.—This invention relates to torpedoes of the kind employing a system of cooling the exhaust gases, comprising a number of tubes, through which the exhaust gases circulate, and the invention has for its object to provide improved means for exhausting the motive fluid from such torpedoes and for effectively cooling the exhaust gases. The motive fluid is generally composed of burnt gases and steam, the volume of which it is necessary to reduce in order to prevent a counter-pressure having a high value, which would interfere with the proper utilisation of the energy of the fluid. According to this invention, the compartment containing the tubes is in free communication with the external water, so that the water can freely enter and escape from the compartment under the pressure of the water existing at the depth to which the torpedo may be submerged, the gases being exhausted in known manner. In the constructional form illustrated, the motive fluid coming from the generator enters the distribution-chamber B through the conduit A. Thence, suitably expanded by the nozzles C, it acts on the turbines D, which, through the medium of toothed gearing (not shown) controls the shaft-end F connected with the hollow shaft G, which



transmits the movement to the propellers. In the plate H, enclosing the turbine D, and the plate J, a number of pipes I are provided, which serve to carry the exhaust motive fluid. The compartment K in which these tubes I are situated freely communicates with the exterior through the orifices N formed in the hull. When the torpedo is submerged, water admitted through the orifices N enters the compartment K, and surrounds the pipes I. It will be readily understood that the motive fluid is subjected to an energetic cooling action inside these tubes. The cooled fluid subsequently enters a fluid-tight compartment P, and is drawn in by a bladed wheel R integral with the driving-shaft, which forces the said fluid into the hollow shaft G for exhausting in a rearward direction. A pump Q drawing in at the lower part of the compartment P rejects externally the condensed products; it may be readily driven by means of an eccentric keyed on the driving-shaft. The pump Q, as shown in Fig. 2, draws in the condensed products at the lower part of the compartment through the pipe X, and discharges the said products to the exterior through the pipe Y. This pump is operated by means of an eccentric V keyed on the shaft F of the propeller of the torpedo. (*Sealed.*)

MINING, METALLURGY, & METAL WORKING.

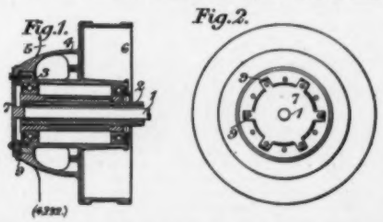
4291/15. E. Hall, Birmingham. Crucible Furnaces. [2 *Figs.*] March 31, 1915.—This invention relates to crucible furnaces, particularly such as are employed for brass-casting and like purposes, such furnaces being of the type in which provision is made for access of air to the furnace around the sides of the grate as well as between the fire-bars. The object of the invention is to provide in a more convenient manner than heretofore for an efficient air supply, with the avoidance of the difficulties and inconvenience attendant upon the removal of clinker from the ordinary fire-grates in the endeavour to prevent choking of the air-admission spaces therethrough. The invention comprises the combination of an air-supply or air-admission box, which is open at the front and bottom, a detachable grate-frame supported within the box and adapted to provide air-passages along its sides, and a detachable cover with central aperture, which cover is arranged over the said passages. In the application of the invention as shown, the fire-grate, which may comprise either fire-bars *a* or a perforated or solid plate, is carried by a detachable grate-frame *b*, which is itself carried within a box *c* constituting the air-admission box. The grate-frame rests upon seating-lugs *d* at the corners of the box, and it is so shaped as to provide air-gaps or spaces *e* between its sides and the inner walls or surfaces of the air-box. Below the seating-lugs, the inner walls of the air-box taper or are downwardly inclined, as indicated at *f*, to the central aperture *g* in the bottom of the box which provides both for air admission and the exit of ashes to the ash-pit A. A further air-admission aperture *i* is provided at the front of the box. The air-ducts or passages *e* formed between the exterior edges of the grate-frame *b* and the inner walls of the air-box *c* are kept clear of fuel by a detachable cover *j*, which is supported on the top of the box, and also by corner pieces *d*1, projecting from its under side, which rest upon the top of the grate-frame. The top or



cover has a central aperture *k* therethrough, enabling the crucible to pass through same, to rest upon the fire-grate beneath it. The combined grate and air-box as aforesaid is built in with the brickwork of the furnace, which is constructed and arranged in any convenient manner. To avoid having to take down the whole of the upper brickwork when it is so required to renew the top or cover *j*, the latter may be constructed with a central removable part *j*1, which fits into and is supported by the main part *j*. The firebrick lining *l* of the crucible chamber *m* is supported on the detachable top *j*1. When the lining and the detachable part become burnt they are removed, and a new detachable top *j*1 and lining can be placed in position without disturbing the rest of the furnace structure. Any ordinary top flue and cover are provided for the upper end of the crucible chamber. Such dampers or the like as may be required are fitted to the furnace to control the air supply. Removal of clinker is effected by a poker either from the top of the crucible chamber or through the front opening *i*. (*Sealed.*)

MOTOR ROAD VEHICLES.

4292/15. Firm Adolph Saurer, Arbon, Switzerland. Detachable Wheels. [2 *Figs.*] March 2, 1914.—This invention relates to detachable wheels for motor-cars and the like in which the wheel is detachably mounted on a rotatable collar or internal hub carried by the wheel axle, the wheel receiving motion from a driving-shaft arranged within the axle. It has been proposed to transmit the power directly from the shaft to the wheel by providing on the shaft a toothed dog or driving-disc adapted to engage with slots formed in the rotatable collar and in the hub proper of the wheel. The invention has for its object to provide an improved construction of such a wheel. According to this invention, the driving-disc is engaged with the wheel for the direct transmission of power, and is fixed or



secured, by independent means, to the rotatable collar, to which also the wheel is secured. By such an arrangement it is possible for either the wheel or the shaft to be detached or removed without disturbing the fixed relationship of the shaft or the wheel with the rotatable collar. 1 denotes the driving-shaft, 2 the rear axle, and 3 the rotatable collar mounted on ball-bearings. The wheel having a hub 4, spokes 5, and the brake-drum 6 attached thereto, is detachably mounted on the collar 3. The lugs or claws 9 of the driving-disc 7 on the end of the driving-shaft 1 take into corresponding recesses in the hub 4, whereby the driving-shaft and the wheel are directly coupled together. In addition the shaft is connected by screws with the collar 3, and the hub 4 is similarly connected with the collar 3. (*Sealed.*)

100,010. R. L. D'Espujols, Joinville le Pont, France. Flash Steam-Generators. 4 *Figs.*] January 30, 1914.—This invention relates to high-speed vaporisation steam-generators or flash steam-generators more especially intended for use upon steam automobile vehicles, and adapted to be heated by means of any suitable liquid fuel, such as petrol, naphtha, heavy oil, or the like. According to the invention, the generator comprises a collector divided into two compartments, one of which is in communication with the water circuit, and the other with the steam circuit, and a series of tube-cages or sockets of tapered form fitting into the said collector, and with each of which are connected two or more staggered elements of a nest of tubes providing a horizontal, but ascending, circuit for the water fed to the collector. Fig. 1 is a cross-section showing a part of the collector, with two tubular elements and their corresponding cage, and the adjacent pair of tubular elements. For convenience the cage 10 is shown as rotated through 90 deg. with reference to the collector 7 and

the tubular elements 12. The generator comprises a lower collector 7 divided into two compartments 8 and 9 by appropriate partitioning, as by a diaphragm 15, the lower compartment 8 being in communication with the water circuit, and the compartment 9 with the steam circuit. Upon this collector 7 there are mounted cages 10, which are of tapered form and are fixed in position in sections formed in the collector 7 and the diaphragm 15 by means of a stay member 16, a tension member 17, and a nut. The nest of tubes is constituted by drawn weldless tubes 12. Each cage 10 receives two staggered elements, as shown at the upper part of Fig. 1, with the object of baffling the circuit of the heating gases so as to retard their flow and deprive them of their heat more completely. The cages may, however, be provided to receive

Fig.1.

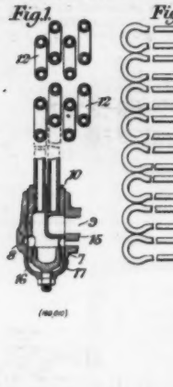
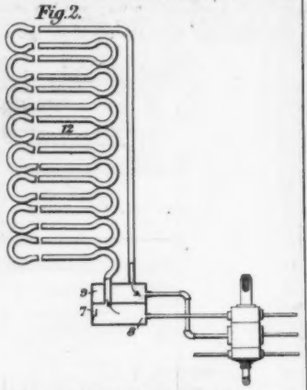


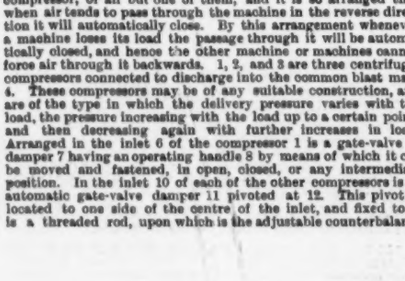
Fig.2.



more than two elements. It will be observed that in the construction of the collector as illustrated in the drawings the adjacent cages 10 are staggered in position relatively to the length of the collector. The tubular elements 12 of the adjacent cages, however, extend side by side, as indicated in the upper part of Fig. 1. The water proceeds from the feed-pump to the lower compartment 8 of the collector 7 and enters through the cages, being uniformly distributed amongst all the elements of the nest 12. The steam produced flows upwards, becomes dried in its passage, and returns through the down tubes. (*Sealed.*)

PUMPS.

10,192/15. The British Thomson-Houston Co., Ltd., London. (*General Electric Co., Schenectady, U.S.A.*). **Centrifugal Compressors.** [1 *Fig.*] July 13, 1915.—This present invention relates to centrifugal compressors, and particularly to the operation of two or more such machines in parallel. The invention relates more particularly to centrifugal compressors for compressing air, and will be described as applied to such use, but it will be understood that it is not necessarily limited thereto. When two or more centrifugal compressors are connected to operate in parallel discharging into a common blast main, the load will be fairly evenly distributed so long as the total load is such that that on each machine is of substantial value. This value varies with different installations depending upon the characteristics of the particular machines. When the total load falls below this value, there is a tendency for one machine after another to drop its load to the remaining machines which will eventually take all the load and drive air back through the other or others. This has led to considerable difficulty in operating several machines in parallel. In carrying out this invention, an automatically closing valve or damper is provided upon either the inlet side or the discharge side of each compressor, or all but one of them, and it is so arranged that when air tends to pass through the machine in the reverse direction it will automatically close. By this arrangement whenever a machine loses its load the passage through it will be automatically closed, and hence the other machine or machines cannot force air through it backwards. 1, 2, and 3 are three centrifugal compressors connected to discharge into the common blast main 4. These compressors may be of any suitable construction, and are of the type in which the delivery pressure varies with the load, the pressure increasing with the load up to a certain point, and then decreasing again with further increases in load. Arranged in the inlet 6 of the compressor 1 is a gate-valve or damper 7 having an operating handle 8 by means of which it can be moved and fastened, in open, closed, or any intermediate position. In the inlet 10 of each of the other compressors is an automatic gate-valve damper 11 pivoted at 12. This pivot is located to one side of the centre of the inlet, and fixed to it is a threaded rod, upon which is the adjustable counterbalance



weight 14. The weight is so adjusted that it at all times biases the valve slightly towards the closed position. The pivot-pin 12 is offset to such an extent that when the valve is open it will stand a few degrees off centre towards the closed position. 15 is a pin for pinning the valve in the closed position. The valve of compressor 2 is shown closed, but with the pin 15 screwed out so that it may open, and the valve of compressor 3 is shown pinned closed. The positions which the valve and counterweight assume when the valve is open are shown in dotted lines in connection with compressor 2. (*Sealed.*)

SHIPS AND NAUTICAL APPLIANCES.

17,725/15. J. Gray, London, and J. G. Gray, Glasgow. Gyrostatic Compass. [3 *Figs.*] July 23, 1915.—This invention relates to improved methods and devices for the realisation of a compass or direction-pointer depending for its action upon gyrostatic action and the rotation of the earth about its axis. The principle involved is shown in Fig. 1. A frame F^1 is mounted on a vertical axis a, about which it is capable of rotation. Carried on horizontal bearings b^2, b^3 to be arranged in F^1 is a second frame F, the centre of gravity of the entire carried system being below the line of b^2, b^3. Mounted on vertical bearings b^1, b^1 carried by F is a gyrostat G, the axles which attach it to F being rigidly attached to the frame or casing of the gyrostat. One of the axles last mentioned is extended into a crank c^1, and this crank is anchored to the frame F by means of a stretched spring. When the apparatus is set up as shown in Fig. 1, the gyrostat is stable without rotation of its flywheel. The equilibrium position of the gyrostat on F is that in which the flywheel of the gyrostat and the crank c^1 are in the plane of F with the stretch in the spring a minimum. Again, the equilibrium position of the frame F is that in which its plane coincides with that of F^1. Now suppose the gyrostat flywheel set into rapid rotation. If any tilting of the gyrostat takes place about the axis b^2, b^3, precession motion takes place about the axis b^1, b^1, and in consequence the crank c^1 gets out of line with F. A torque delaying the precessional motion comes into existence, and the tilting couple is diminished and annulled. If, when the gyrostat is precessing about the bearings b^1, b^1, the frame F^1 is rotated about a in the direction which results in the frame F turning so as to diminish and annul the want of alignment of c^1 and F, it will be clear that it is a matter of manipulation to ensure that the stable position of the gyrostat relatively to the frame F^1, without rotation of its flywheel, shall be the stable position of the gyrostat relatively to the frame F^1 with rotation of the flywheel. The requisite manipulation of the frame F^1 about the axis a is conveniently carried out by means of a reversible motor controlled by means of a commutator and roller-contacts carried by the frame F and the crank c^1 respectively. This motor is geared up to the axis a. Any tilting action of the gyrostat about the axis b^2, b^2 causes want of alignment between F and c^1, and this want of alignment

Fig.1.

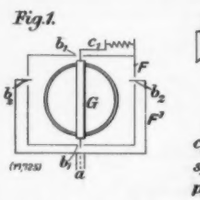
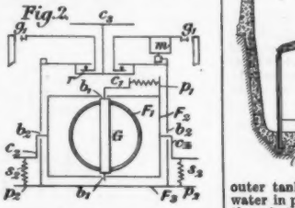


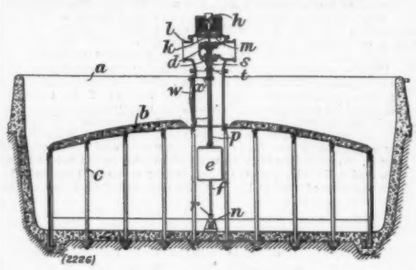
Fig.2.



results in the operation of the motor in the direction which diminishes, and finally, when the gyrostat has ceased to precess, annuls the want of alignment. If the arrangement so constructed is set up at the equator in the earth's rotational field, the equilibrium position of the gyrostat is that in which its axis points true north and south. When apparatus of the nature described is used on board ship, it is desirable that the action should not be interfered with by acceleration or retardation of the ship, or by turning of the ship's head. It is desirable that the centre of gravity of the gyrostat, frame F, crank c^1, &c., should lie in the line b^2, b^2. A suitable construction is shown in Fig. 2. A frame F^2 is suspended by means of gimbal-rings g after the manner employed in the older form of magnetic compass. The frame is capable of being rotated forcibly in azimuth about the ball-race r by the geared motor m. Mounted on horizontal bearings b^2, b^2 arranged in F^2, is a second frame F^3, the axles which attach F^3 to F^2 being extended into cranks c^2, c^2, which are anchored by means of springs s^2, s^2 to arms p^2, p^2 attached to the frame F^2. Carried within F^3 on vertical bearings b^1, b^1 is the gyrostat G, which rotates in the frame F^1. One of the axles which engage in the bearing b^1, b^1 is extended into a crank c^1, which is anchored to a pillar p^1 attached to the frame F^2 by means of a stretched spring. An examination of the figure shows that the equilibrium position of the gyrostat without rotation of the flywheel is that in which the cranks c^2, c^2 are in the plane of F^2 and the crank c^1 in the plane of F^3. The geared motor m is controlled by means of a commutator and contacts carried by c^1 and F^3, and the arrangement is such that when c^1, which is rigidly attached to the frame F^1 of the gyrostat, turns relatively to F^2, the motor comes into action and diminishes and finally (when the gyrostat has ceased to precess) annuls the want of alignment. With this action, the equilibrium position of the gyrostat with rotation is that in which its axis is horizontal, and, in consequence of the rotation of the earth, pointing true north and south. As shown in Fig. 2, the frame F^3 is maintained vertical by gravity, and consequently the axis of the gyrostat is constrained to be horizontal. If, however, the lower ends of the springs s^2, s^2 are attached to points in F^3 which do not lie in the verticals passing through b^2, b^2, the equilibrium position of F^2 will be that in which the stretch in the springs s^2, s^2 is a minimum. If the angles made by each of the springs with the vertical in this position is equal to latitude, the axis of the gyrostat will be inclined to the horizontal at an angle equal to the latitude. With this provision, the equilibrium position of the gyrostat is that in which its axis is parallel to the axis of rotation of the earth. The true north and south direction (which is shown by the compass card c^3) for the position of the compass is the projection of the axis on a horizontal plane lying below or above the gyrostat. (*Sealed.*)

STEAM-ENGINES, BOILERS, EVAPORATORS, &c.

2226/15. The British Thomson-Houston Company, Limited, London, and C. H. Naylor, Rugby. Steam-Accumulators. [1 *Fig.*] February 11, 1915.—This invention has reference to steam accumulators of the expansible-receiver type for receiving an intermittent supply of exhaust steam from a reciprocating engine, and for supplying it at a constant pressure to a prime mover, such as a turbine. There are on the market expansible-receiver type accumulators known as the "bell" or "gasholder" type. The "bell" type accumulator consists of a large cylindrical vessel, closed at the top and open at the bottom. The open end is immersed in a large annular tank containing water, which serves the purpose of sealing the lower end of the vessel, but at the same time allows it to rise and fall. When steam is being stored in the "bell" type accumulator, the floating vessel rises, and when steam is being delivered from this accumulator, the floating vessel descends. This movement of the floating vessel necessitates strong guides and wearing parts. The present invention has for its object the doing away with large, heavy moving parts, and substituting water as the moving element, all the rest of the main parts remaining fixed. This invention consists in the provision of a large water-tank, open at the top, and containing a smaller inverted stationary tank for the reception of the steam, open at the lower end, and provided with automatic valve mechanism for the prevention of over-charging or excessive discharging. In the drawing, a represents the water-tank, which may be of concrete or other suitable material, and for convenience may be inserted in an excavation in the ground, as illustrated. Within this tank is an inverted tank b rigidly secured by means of the standards or columns c. This tank is open at its lower end, so that water can pass freely from the inner to the outer tank, and *vice versa*. Steam is supplied intermittently to the accumulator, and enters the stationary tank b through a conduit connected to the stand-pipe b at the flange. The discharge of steam from the tank to a turbine, for example, is controlled by a valve d. As steam flows into the inner tank, the water is expelled by way of the open space at the bottom of its sides; thus an expansible reservoir is devised having no large moving parts, the movement taking place in the surrounding water medium. When the accumulator discharges its steam, the water flows back from the annular space in the



outer tank to the inner tank, thus filling the inner tank with water in place of steam. In order to obviate excessive condensation of steam into the water, thereby raising its temperature to an unnecessary degree, it is proposed to cover the surface of the water with a layer of oil or other light non-volatile liquid. The accumulator is provided with automatic valve mechanism adapted to prevent excessive charging and discharging of steam. The valve d is a double-beat valve, so as to permit it to open by gravity when there is a vacuum in the conduit leading to the turbine. The tubular spindle of the valve is connected to a tubular extension p, the lower end of which is engaged by the top of the float e when the latter rises. The float e is mounted to slide on a vertical spindle f, which passes through the tubular extension p and the tubular spindle of the valve, and communicates with a relief valve h through a slot-link k and bell-crank levers m. The float e rises and falls on the rod f with the level of the liquid in the tank, and in its uppermost position it raises the tubular extension p so as to close the valve d and prevent the water from rising into the conduit on the top of the accumulator. As the float falls, the valve d is opened, the tubular extension p following the float by gravity until the flange s on the valve spindle meets the stop t. In its lowermost position the float engages the stop r, and depresses the vertical spindle f in the guide n, so as to open the relief-valve h. The relief-valve is provided with weights, and is normally closed, whereas the valve d is normally open. The tubular extension p has a telescopic connection with the tubular valve-spindle, so that it can be adjusted to vary the upper limit of liquid level in the tank and also to permit of the float being withdrawn through the door w in the stand-pipe for inspection or repair. After adjustment a rigid connection between the tubular extension p and the tubular valve spindle is maintained by the screw x. The operation of the device is as follows:—When the water rises in the inner chamber b to such a height as is deemed safe against the possibility of its rising into the stand-pipe, the float catches against the end of the tubular extension p, which is secured to the tubular valve-spindle, and closes the valve d so that no further steam can escape from the accumulator, and consequently the rise of the water ceases. This is, of course, when the accumulator is fully discharged. When charging takes place, and the water descends so low in the inner vessel that there is danger of the oil on its surface being driven out at the annular space at the bottom of its sides, the float then catches against the stop r so as to lower the rod f, and the slot-link k comes against the ends of the bell-crank levers m, causing the other ends of these levers to open the relief-valve h. The incoming steam is then relieved to atmosphere, and the further descent of water in the accumulator is arrested. This, of course, is when the accumulator is fully charged. (*Sealed.*)

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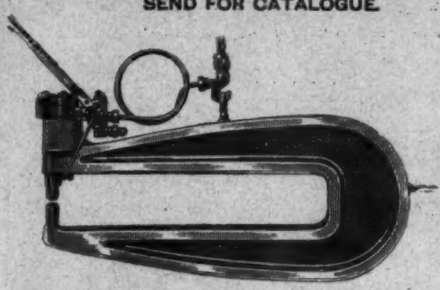
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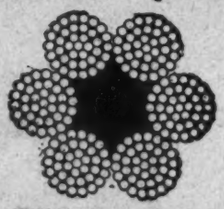
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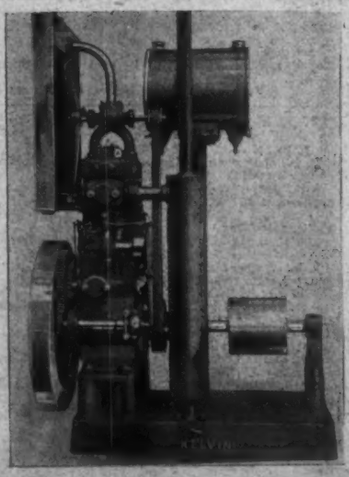
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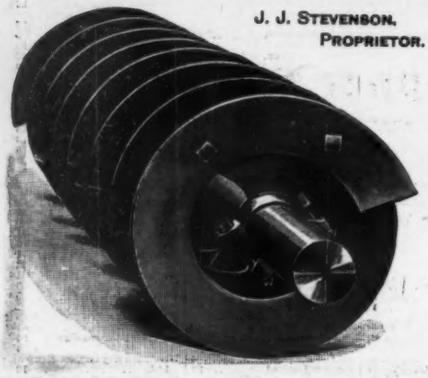

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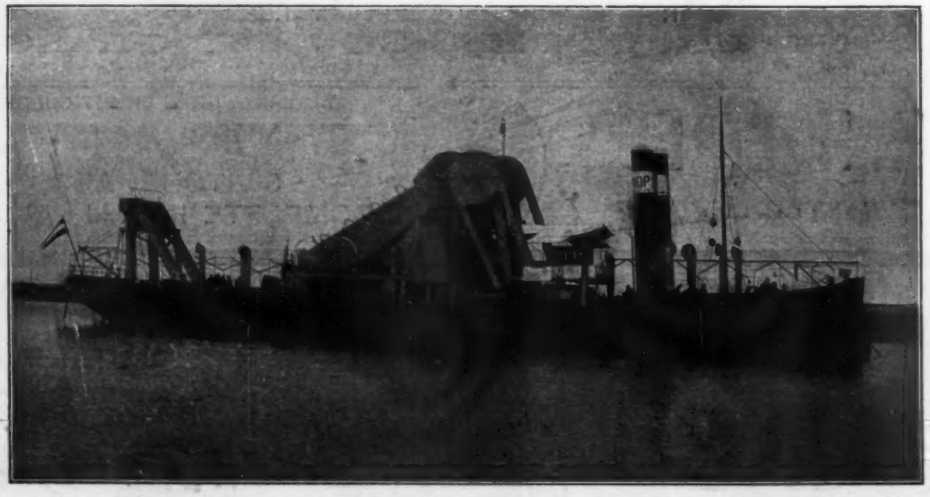

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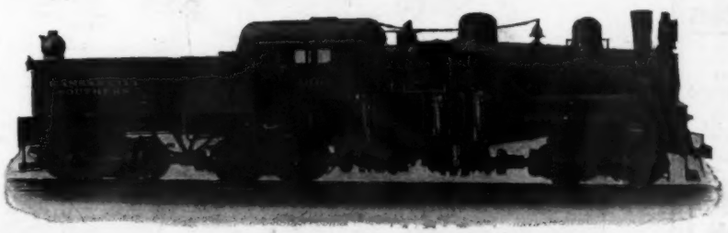

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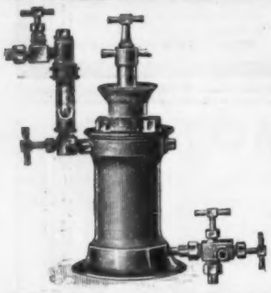

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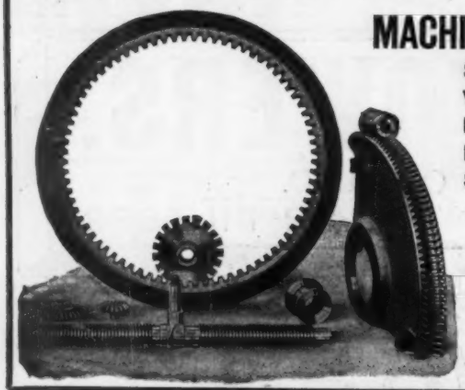

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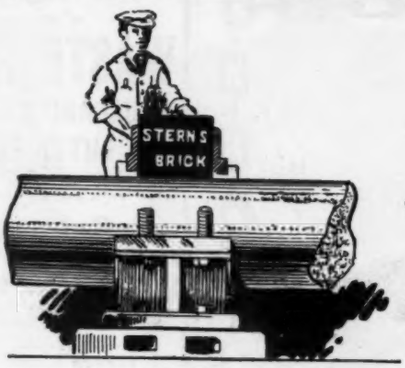

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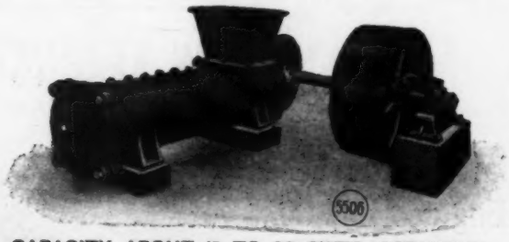

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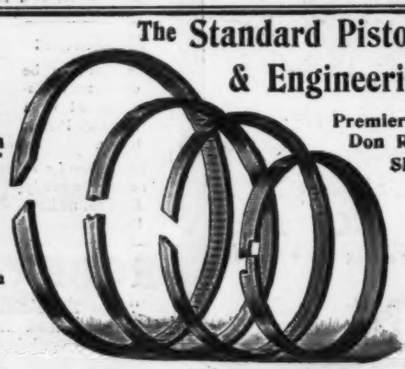

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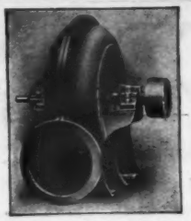

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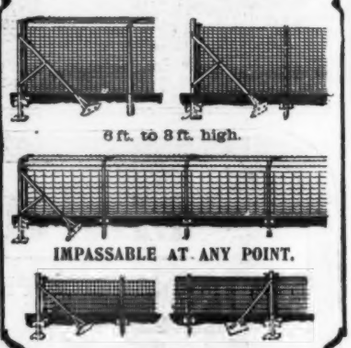

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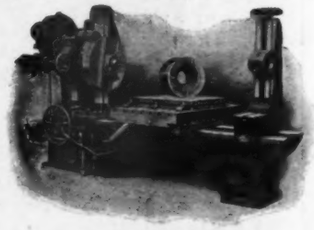

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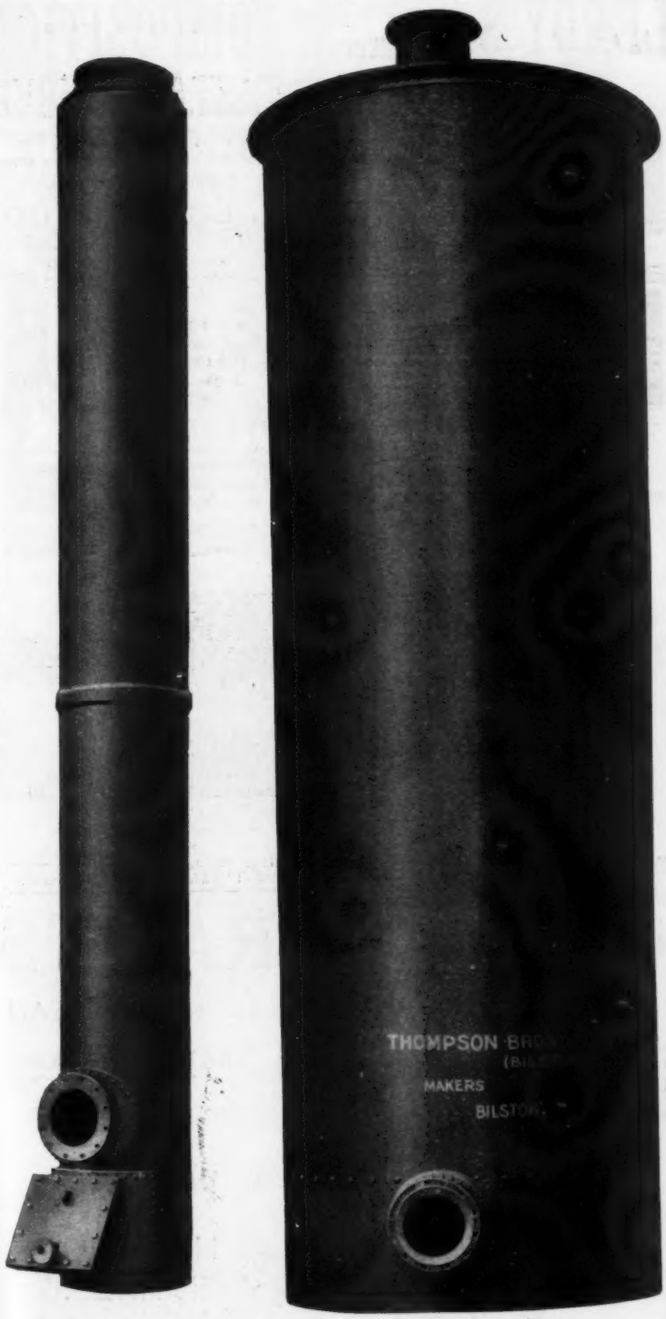

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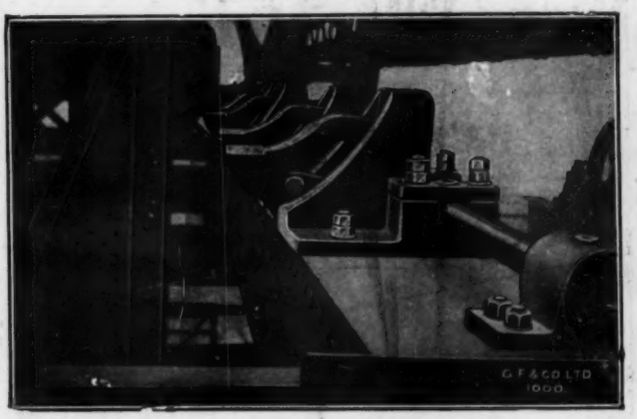

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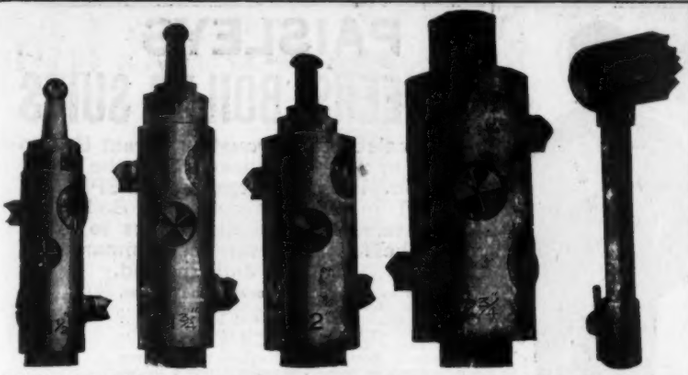

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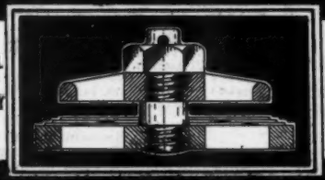

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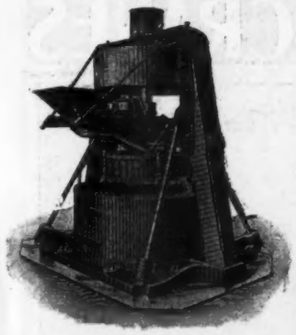

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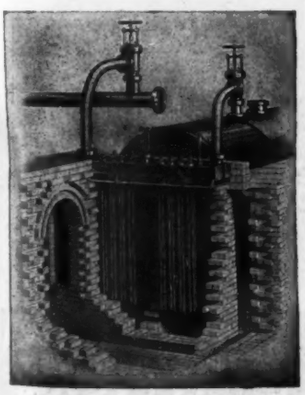

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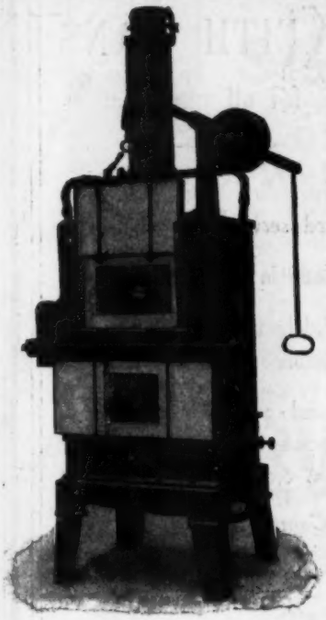

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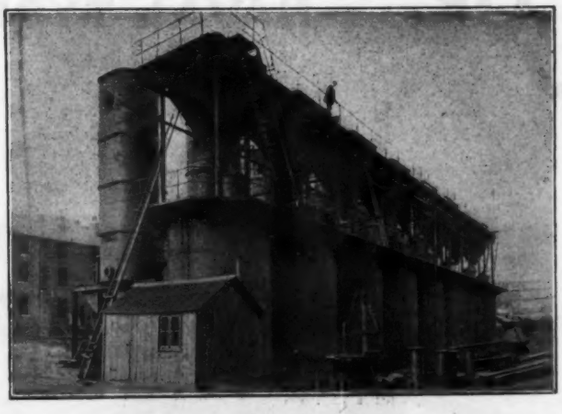

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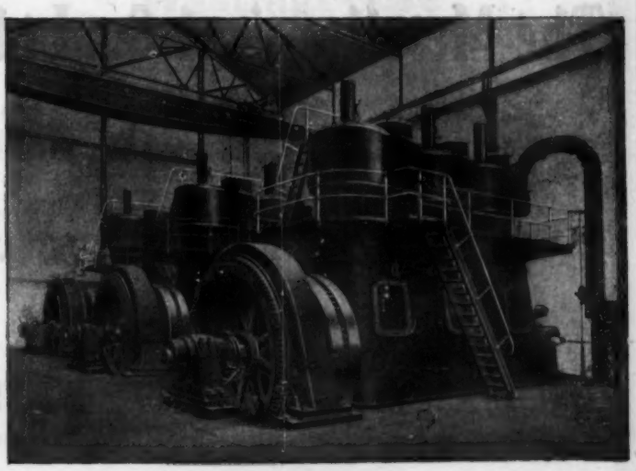

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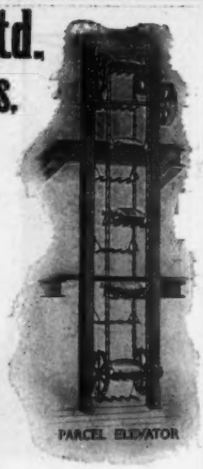
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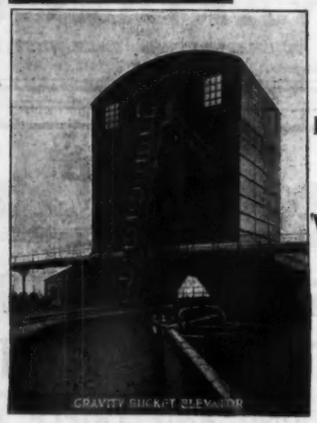
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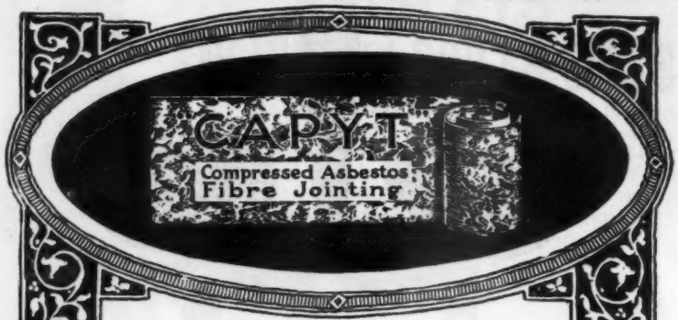

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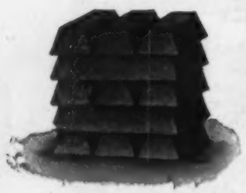

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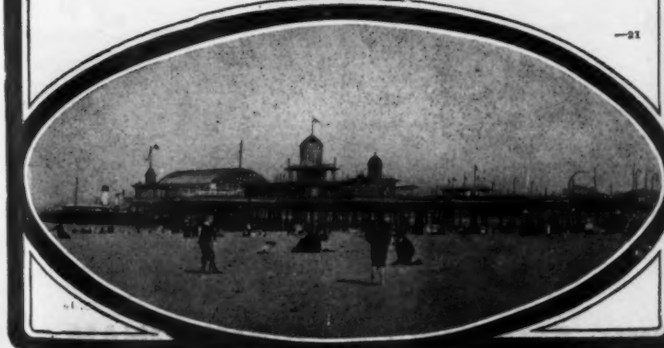

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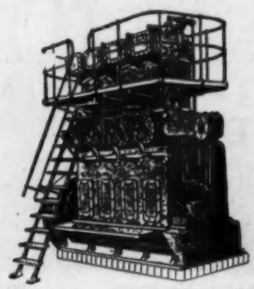

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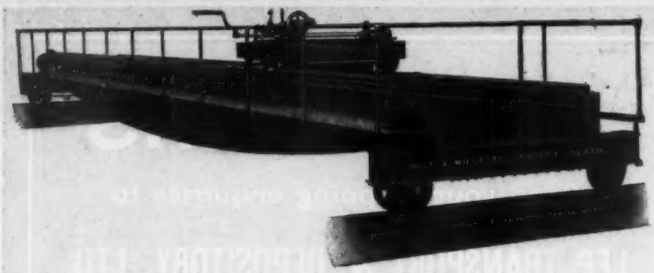

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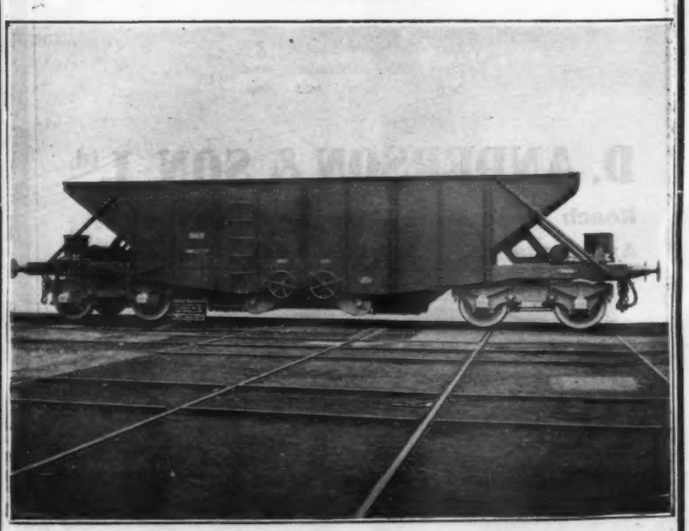

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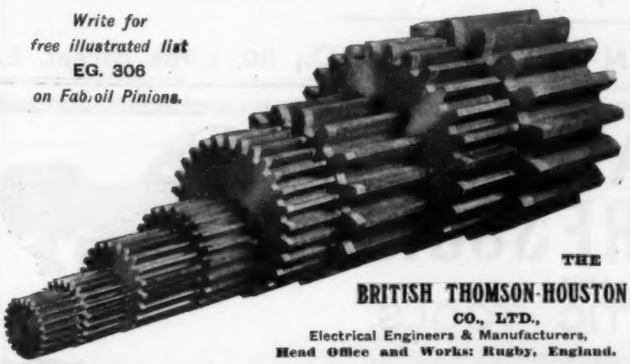

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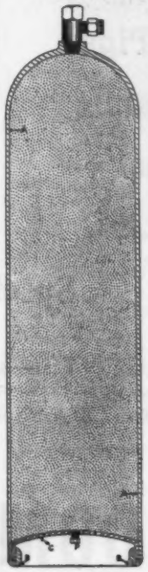

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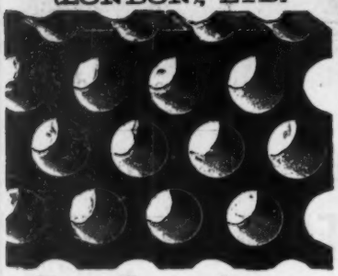

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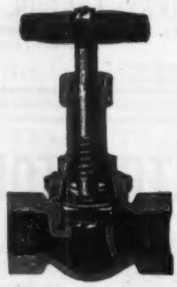

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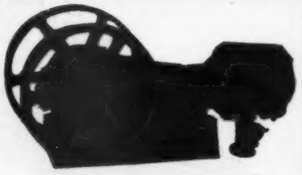

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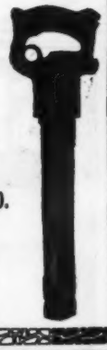

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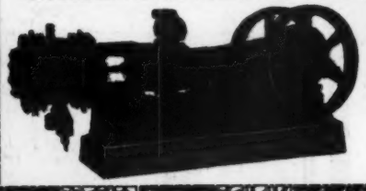

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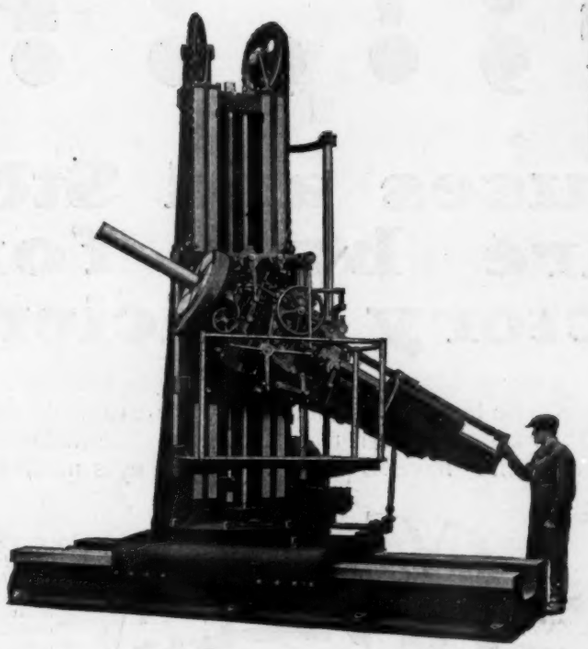

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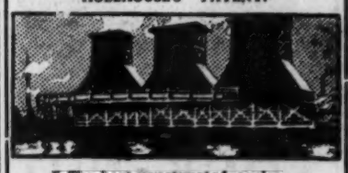

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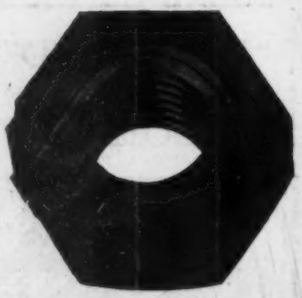

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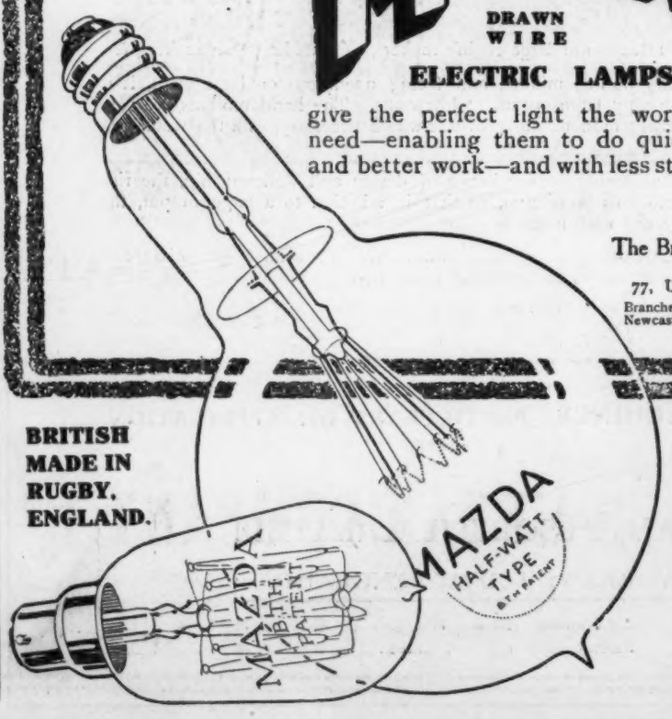

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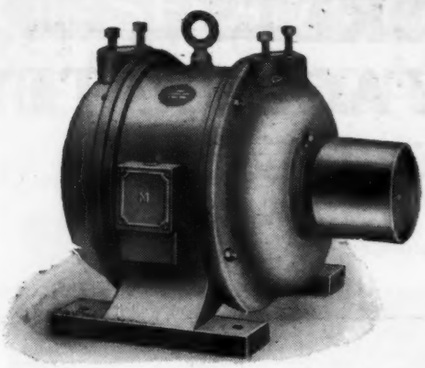

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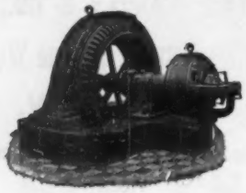

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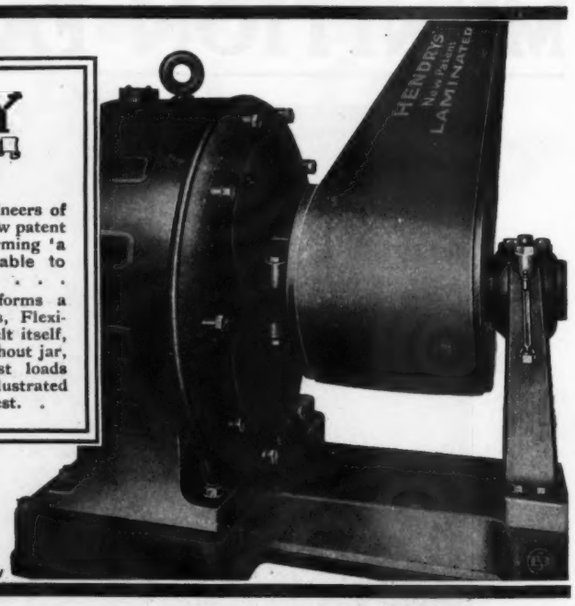

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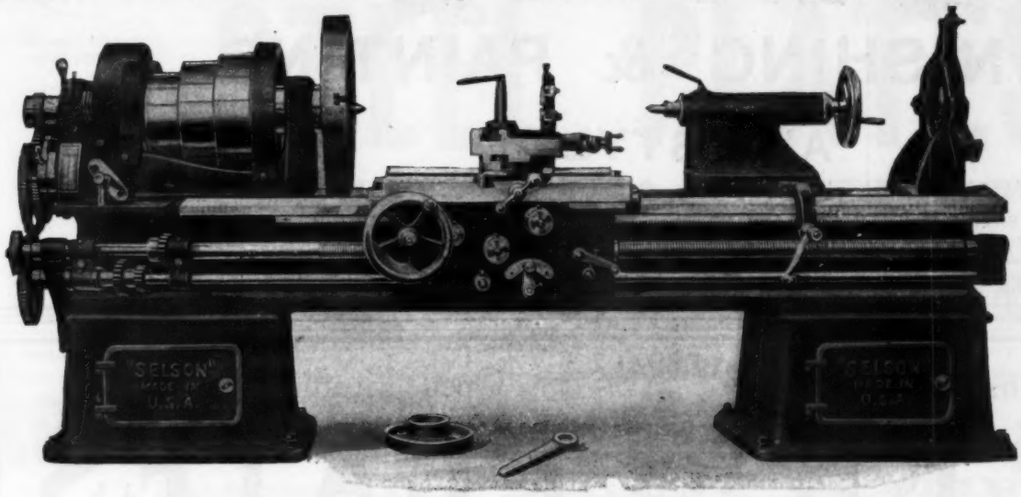

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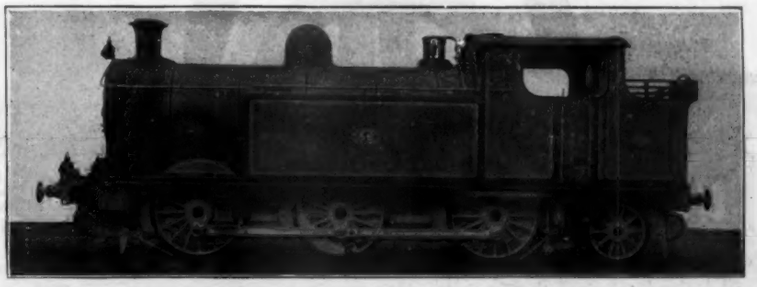

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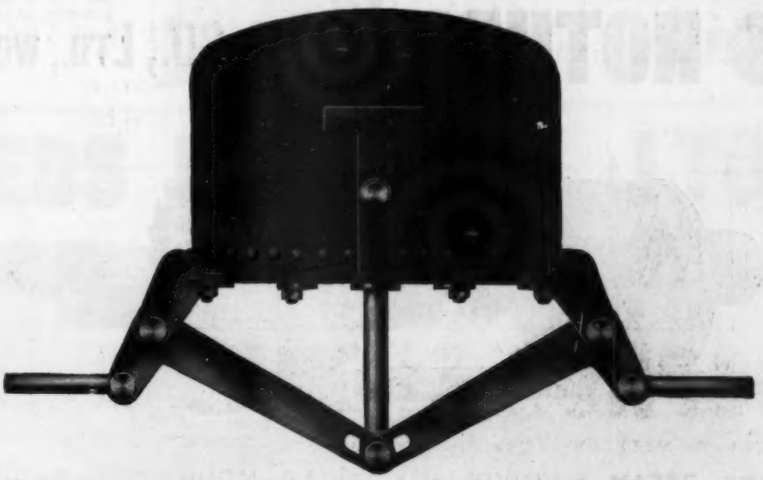

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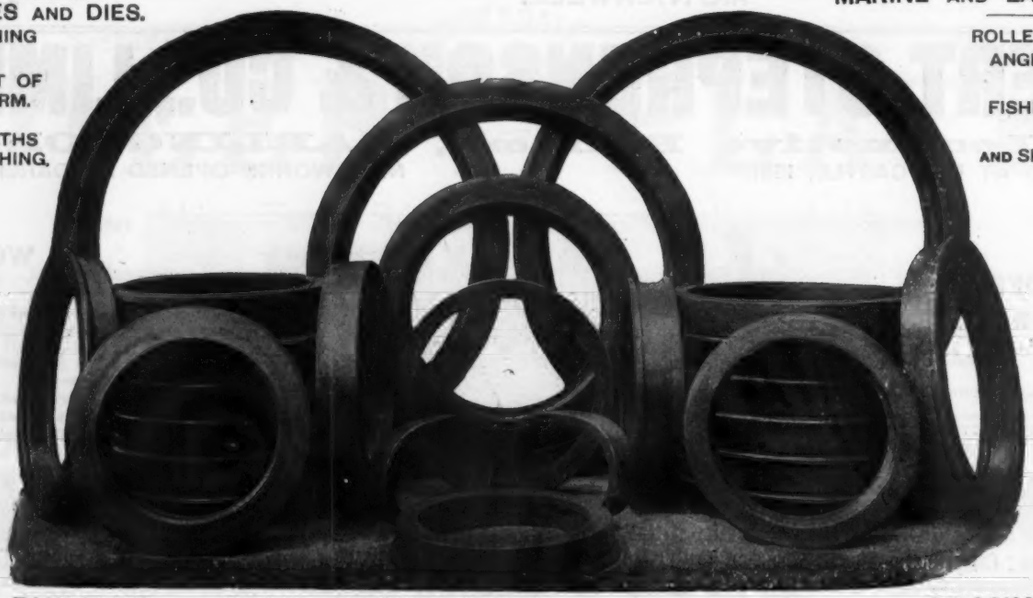

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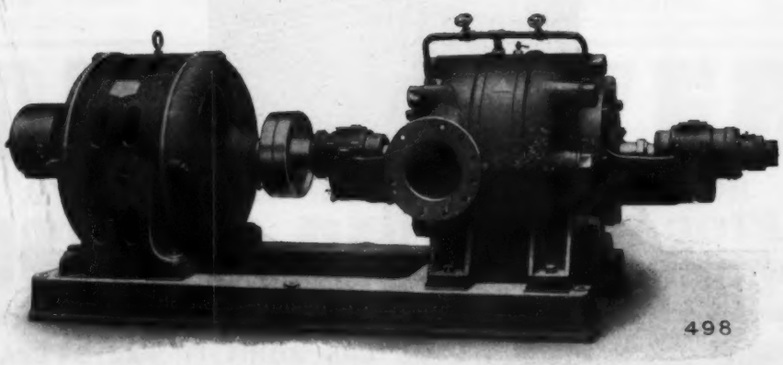

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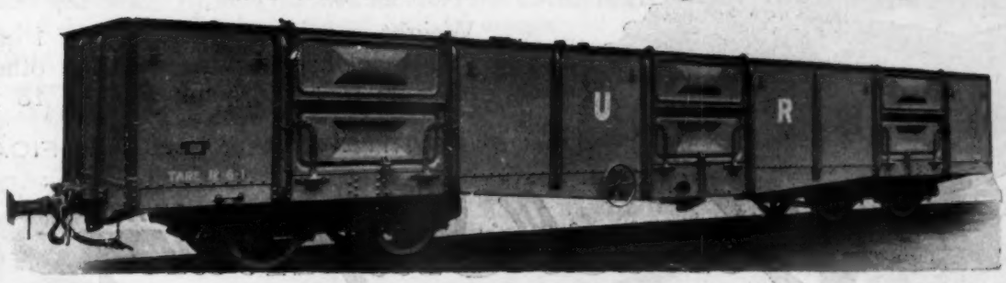

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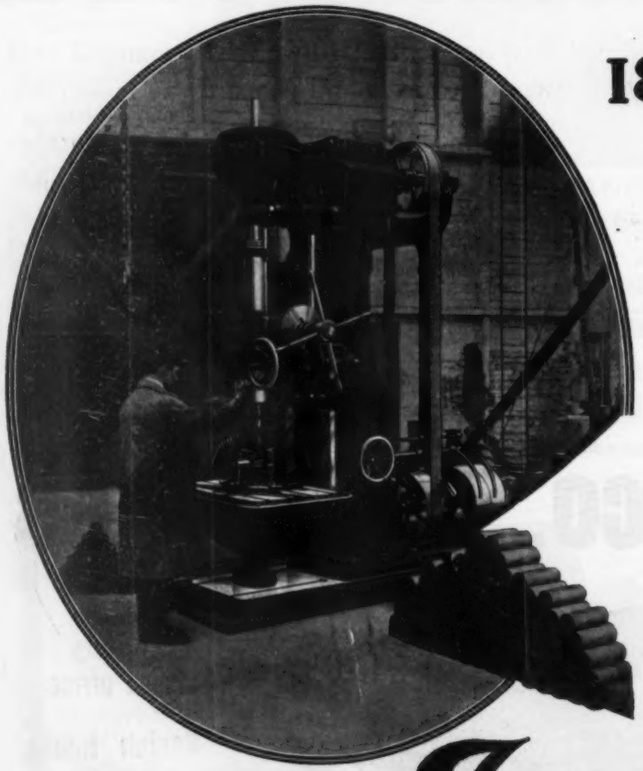

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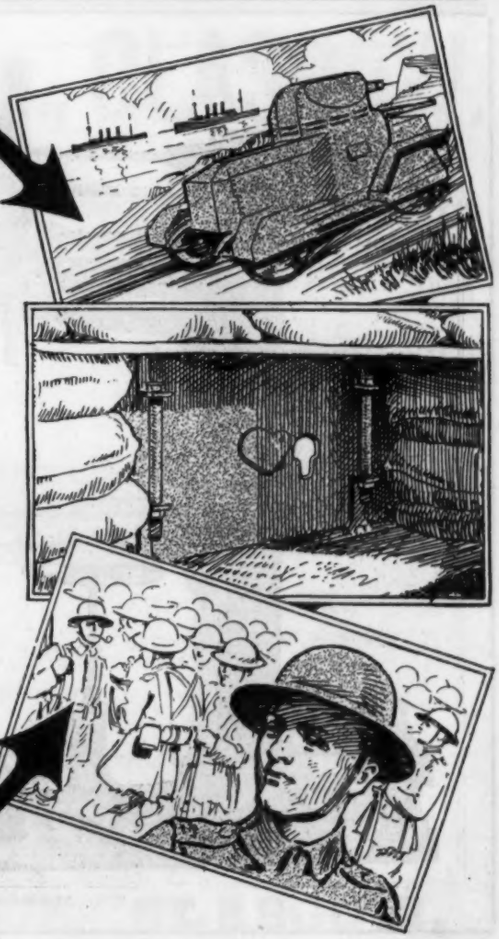

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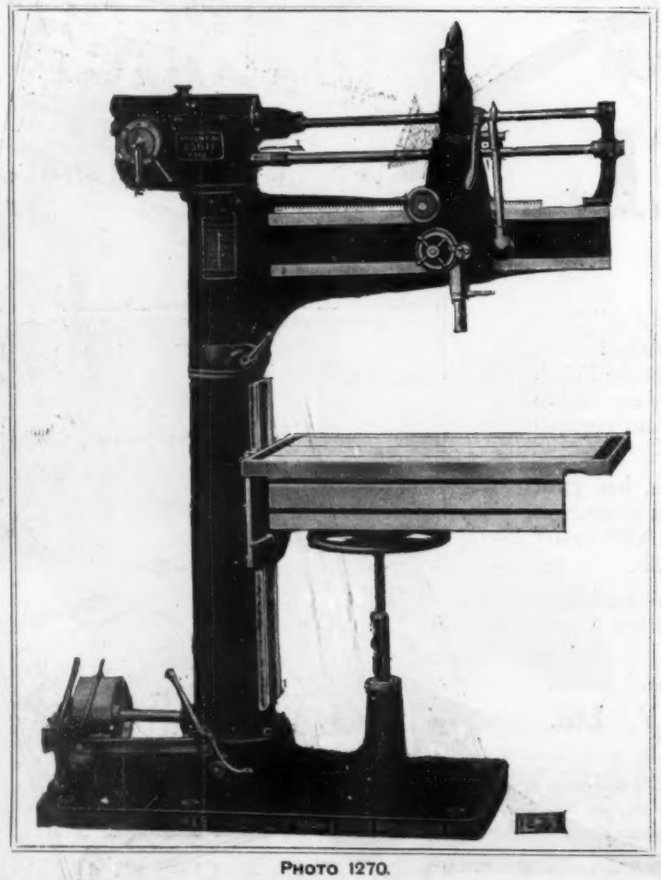

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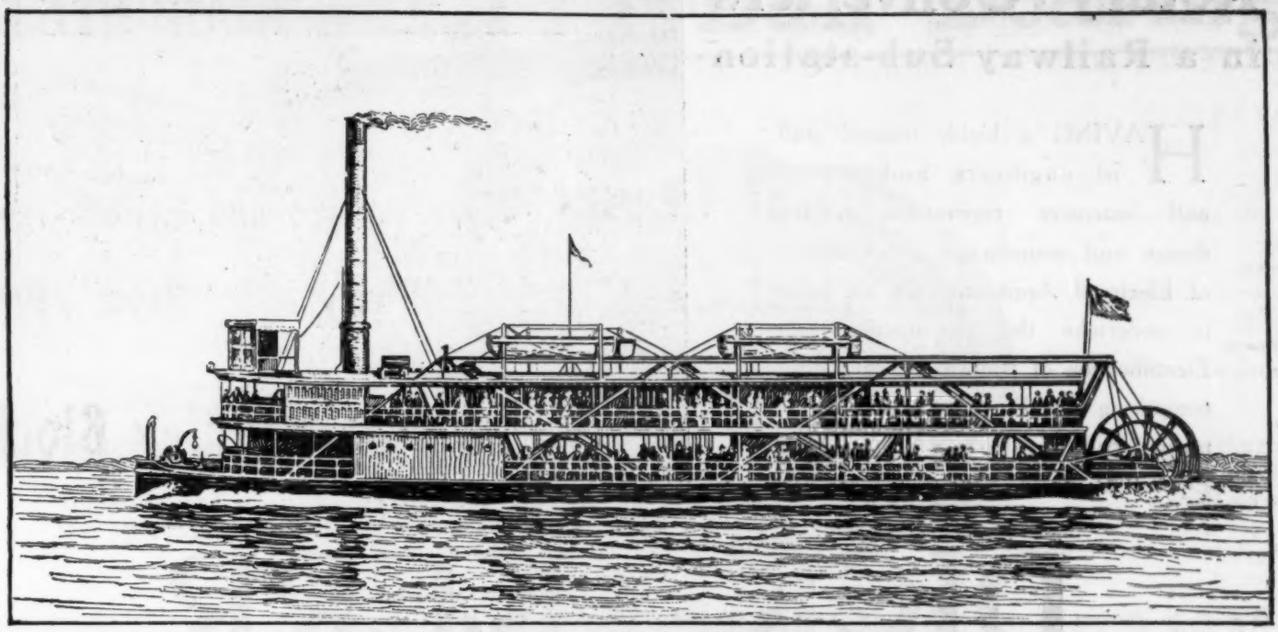

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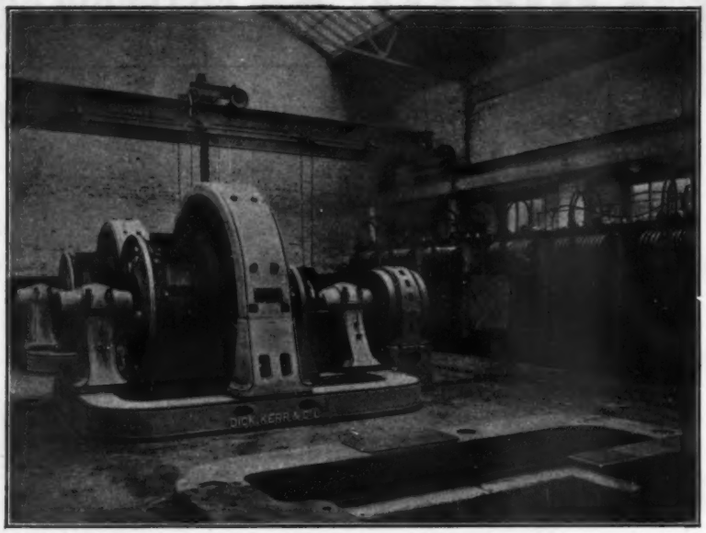

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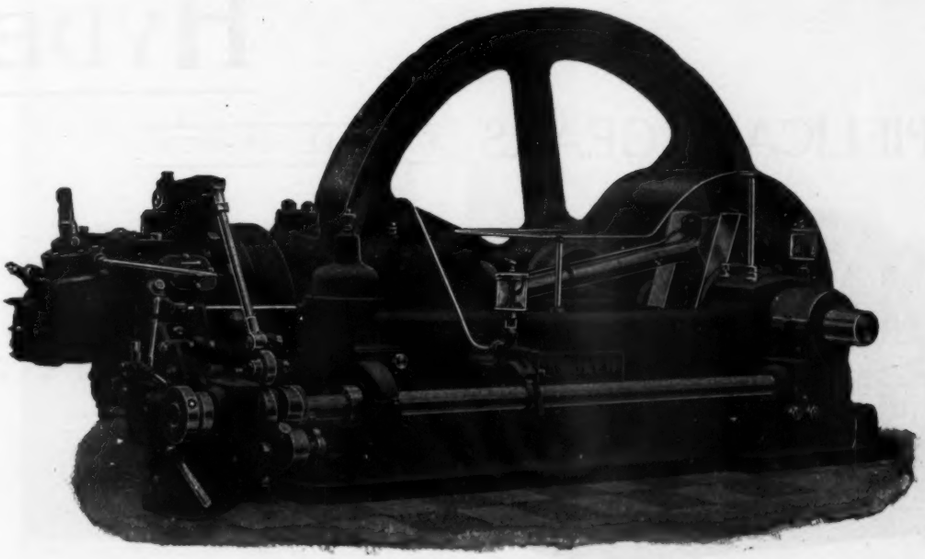

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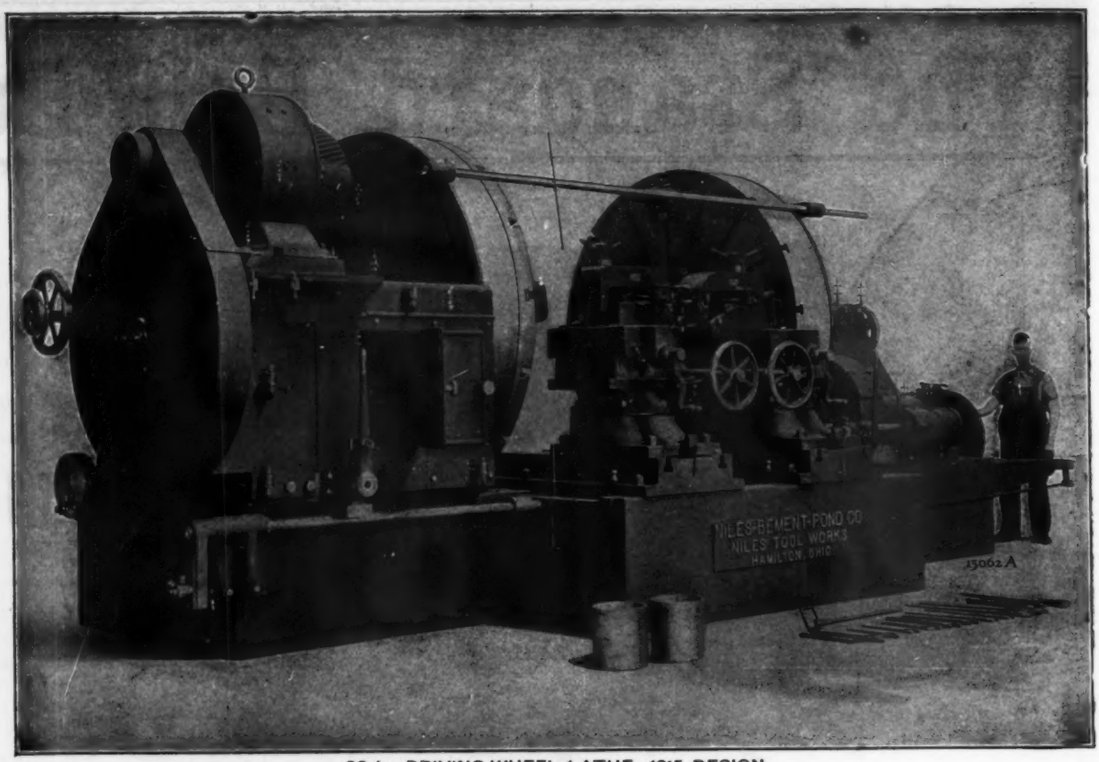

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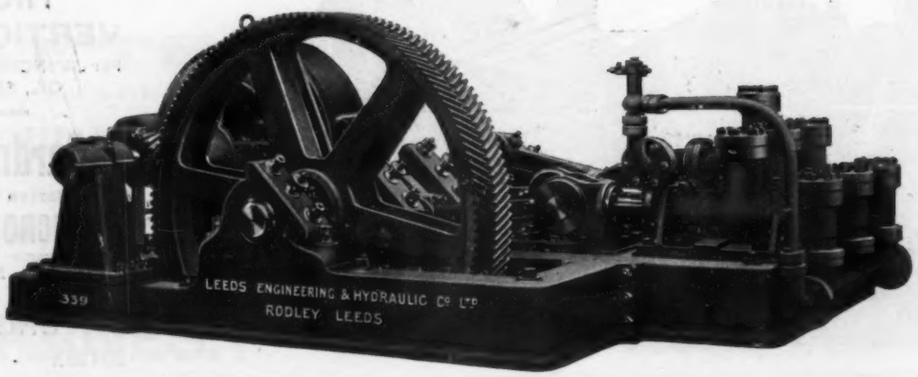

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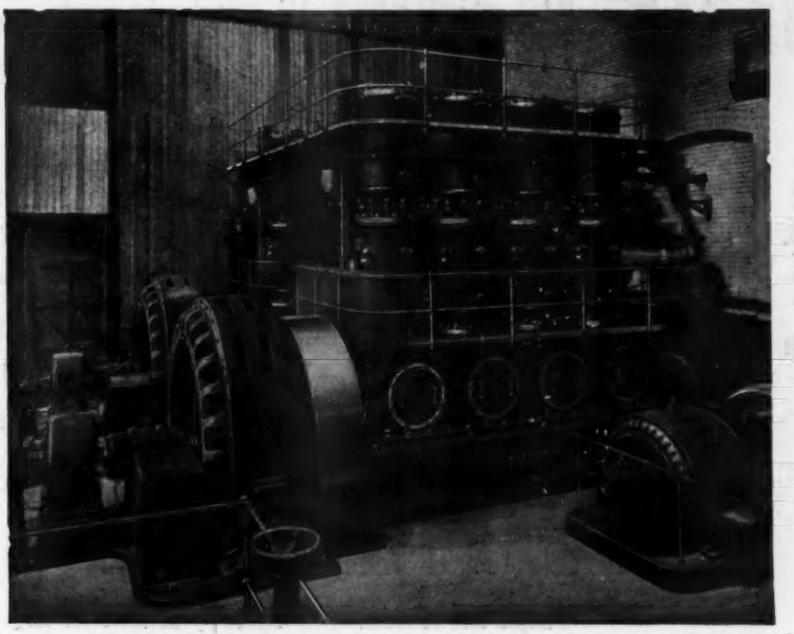

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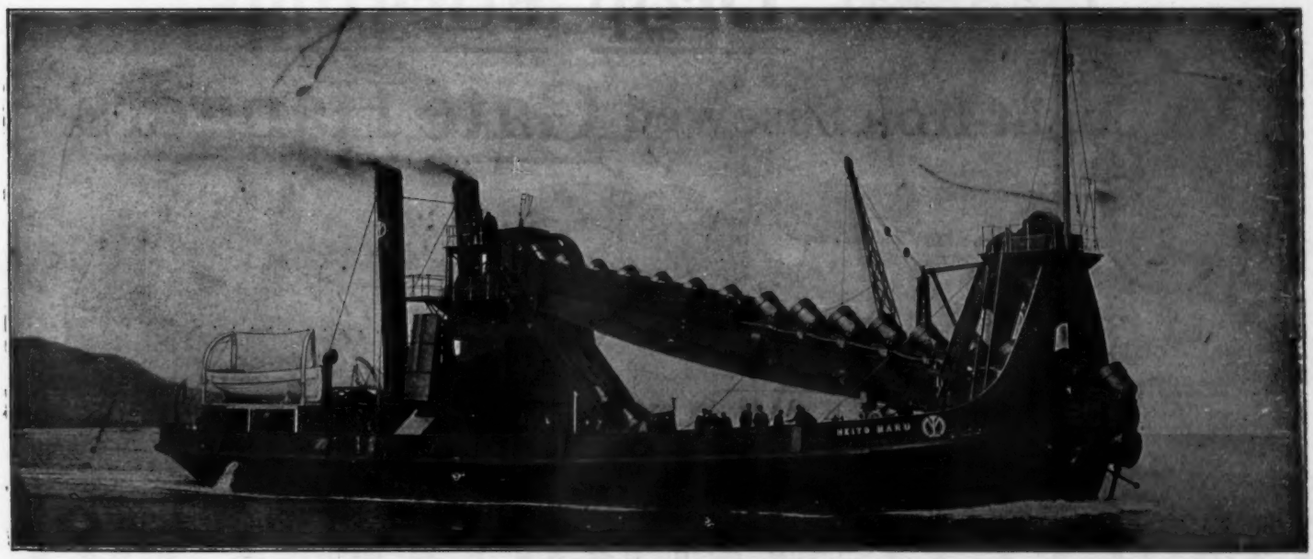

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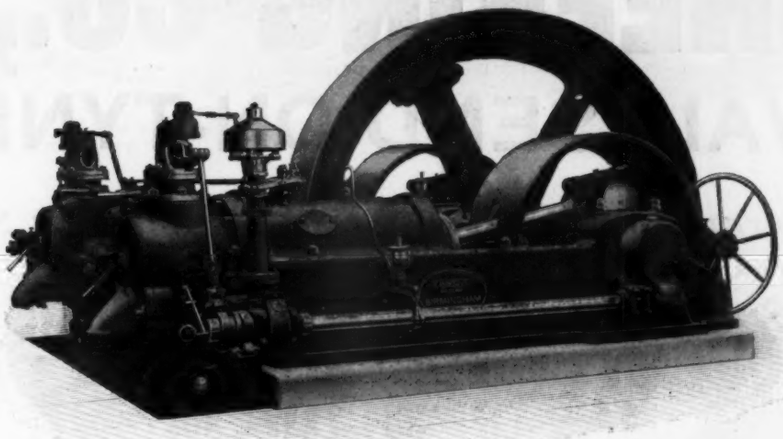

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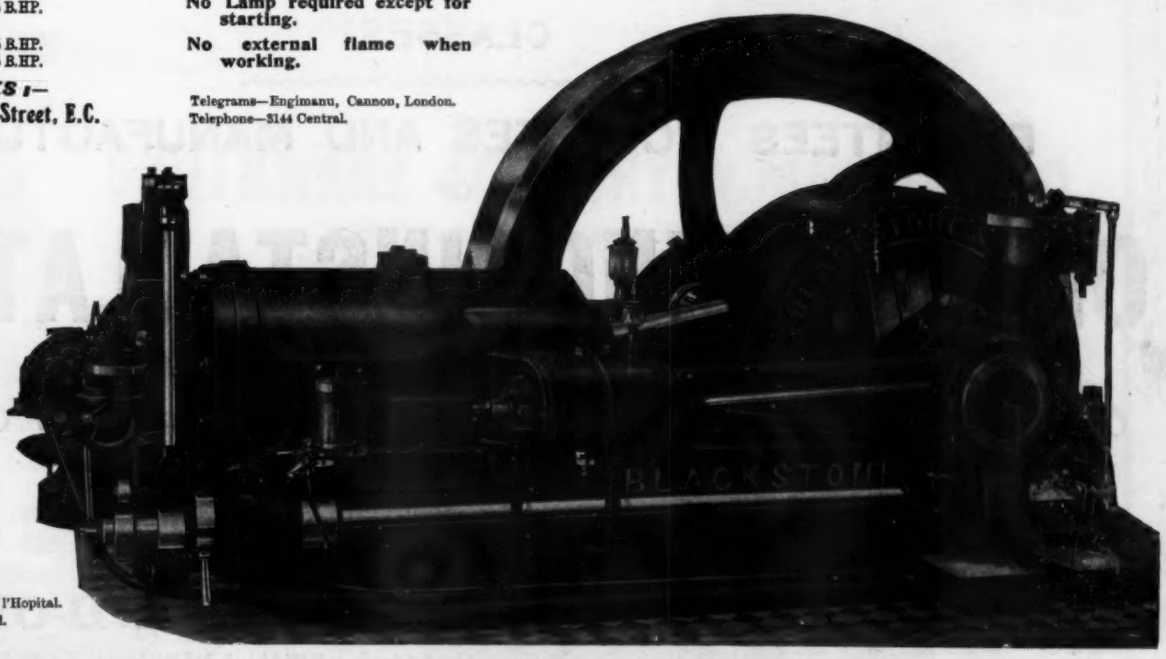

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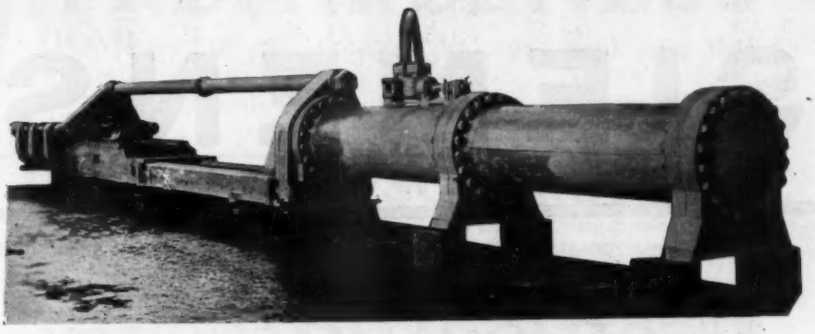

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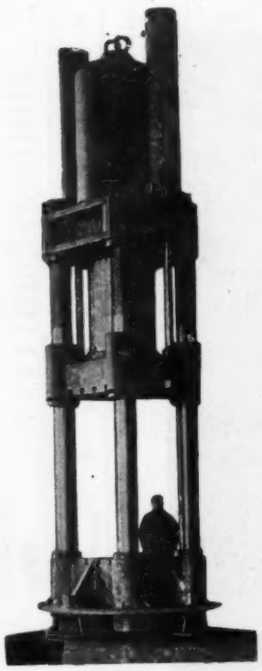

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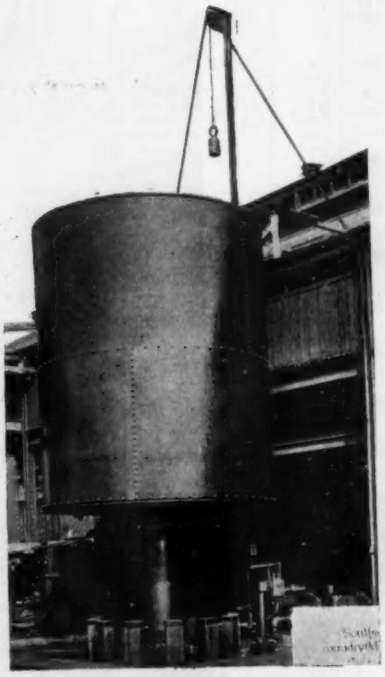

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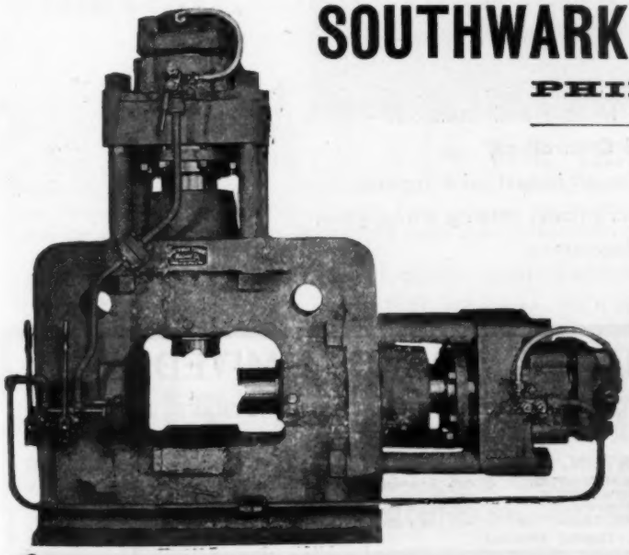

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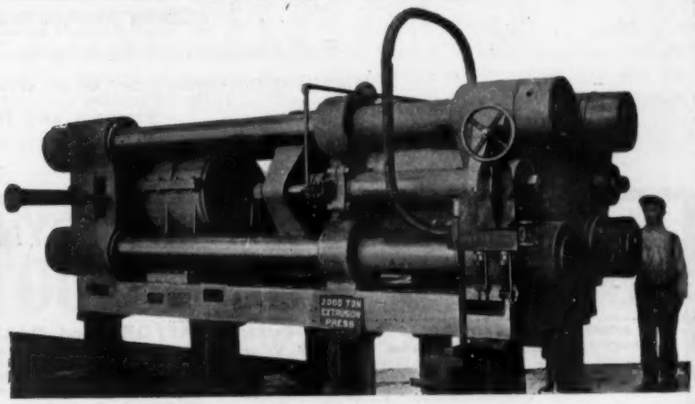

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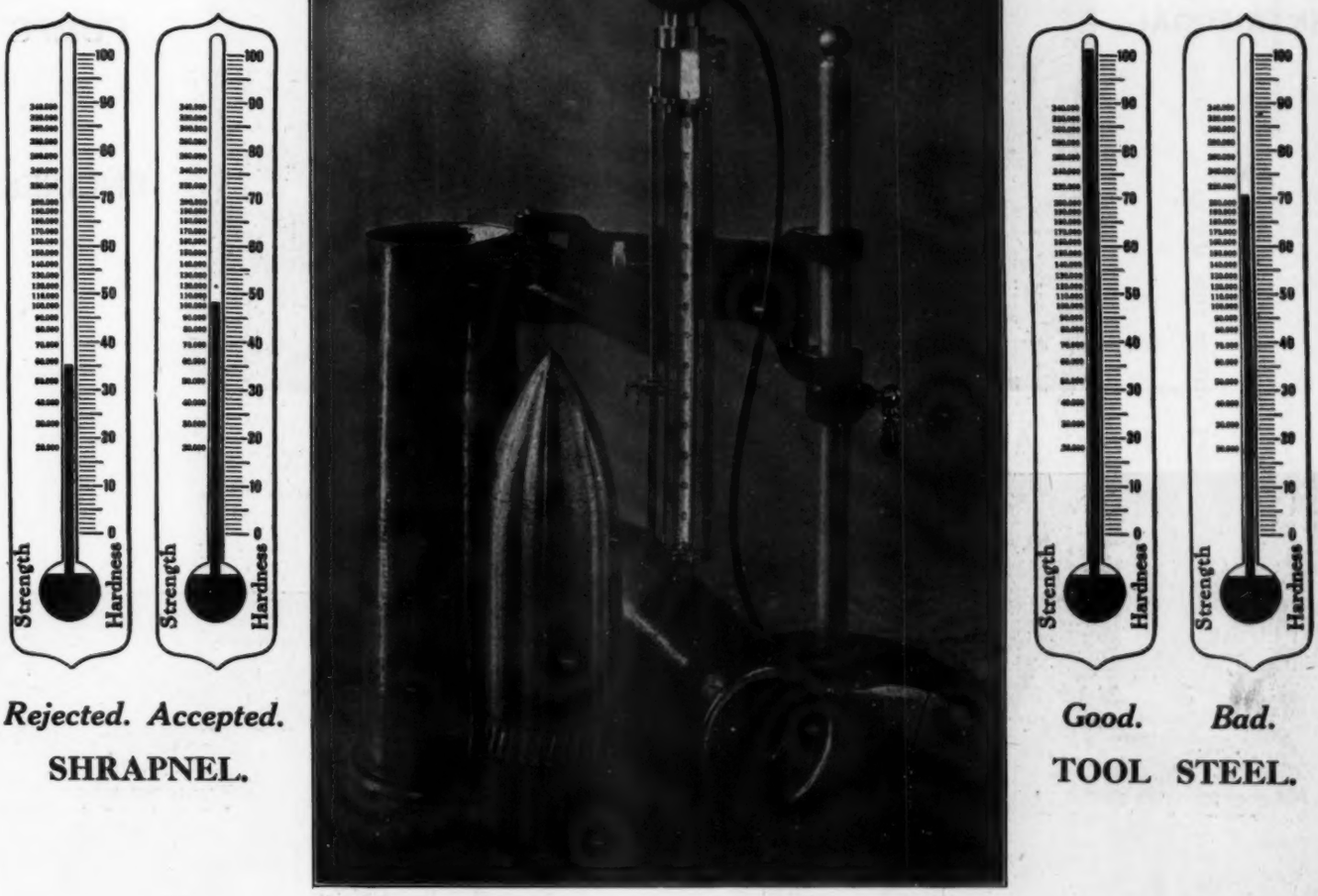

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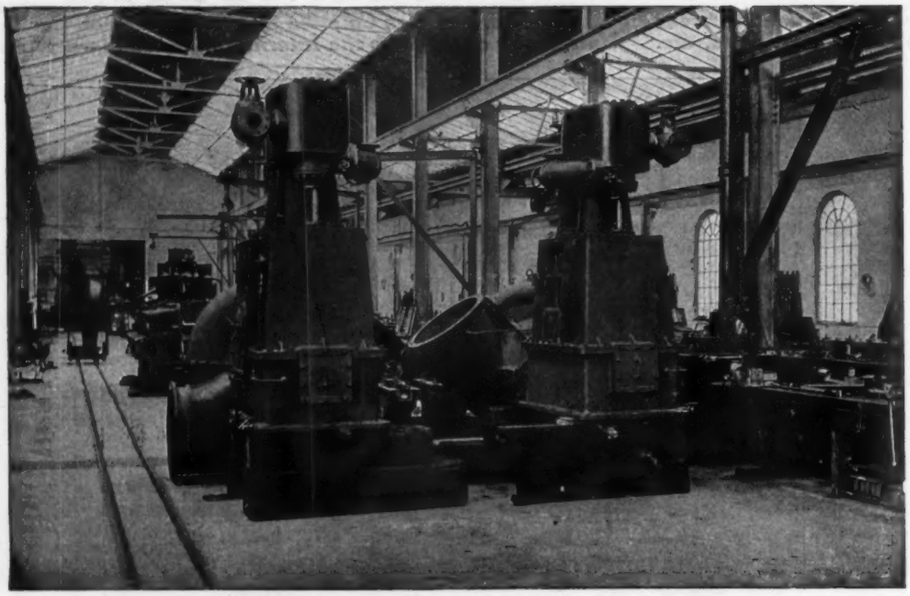

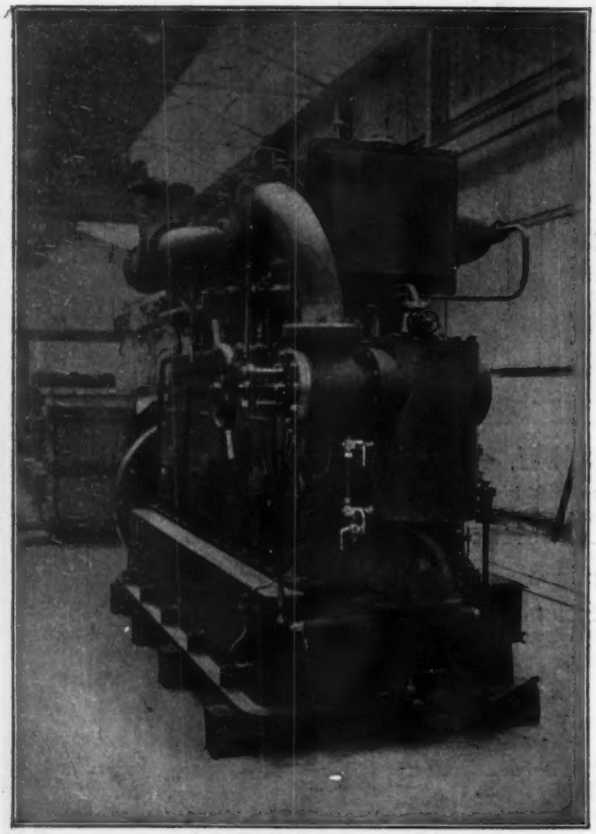

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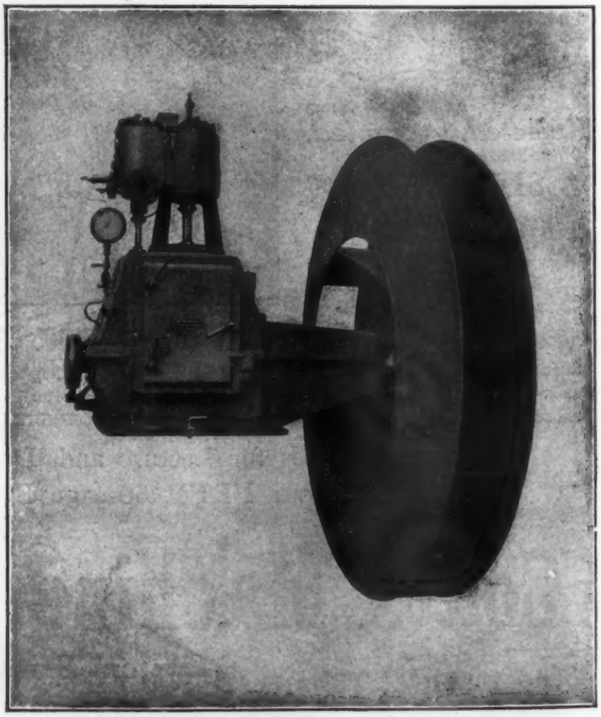

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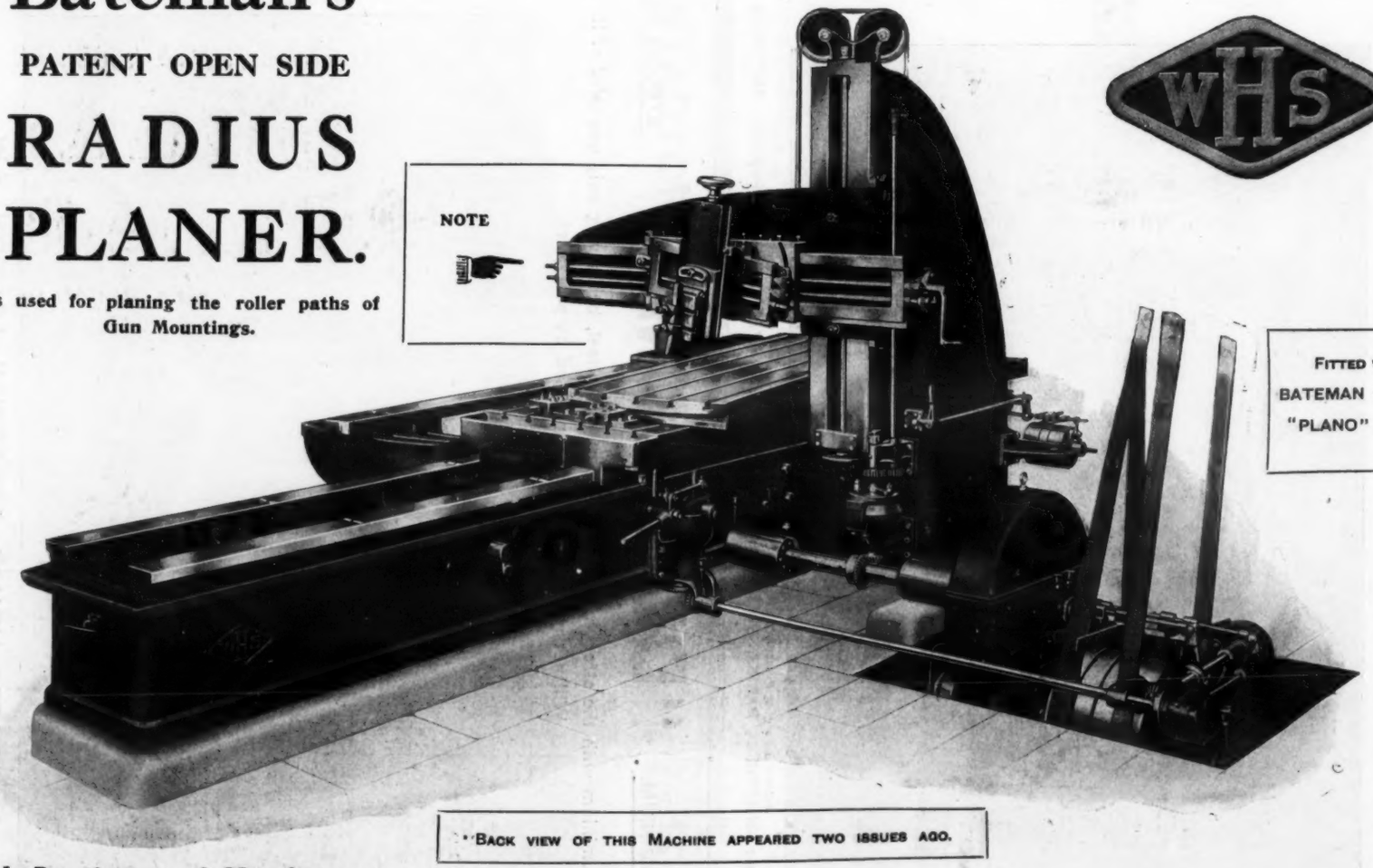

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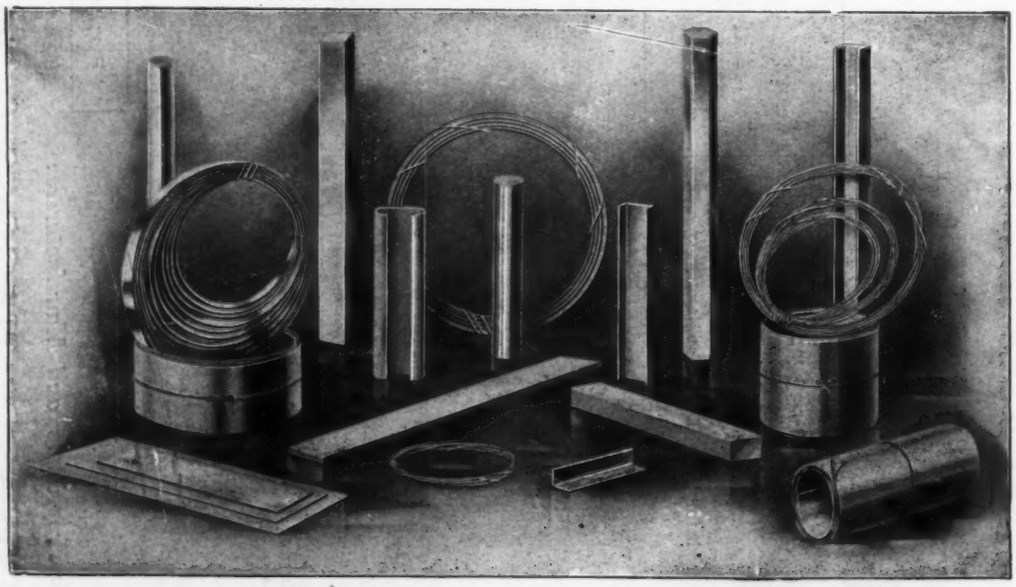

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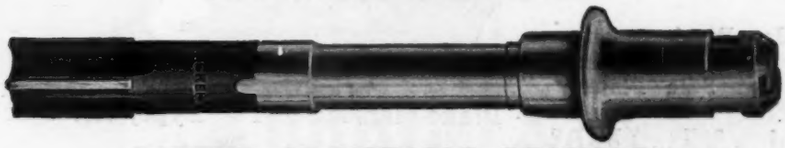

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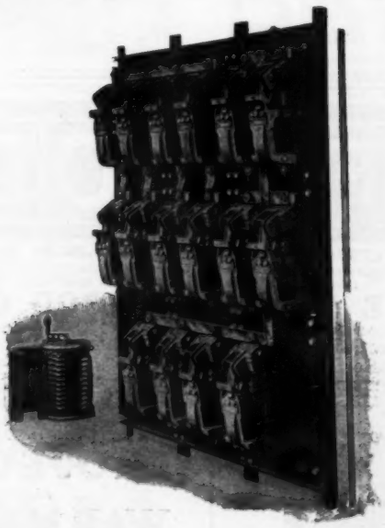

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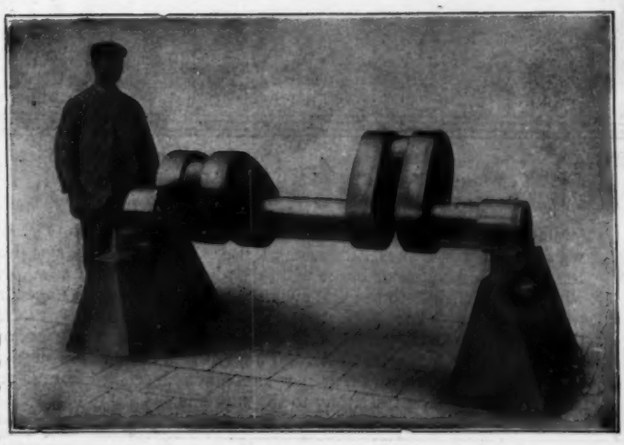

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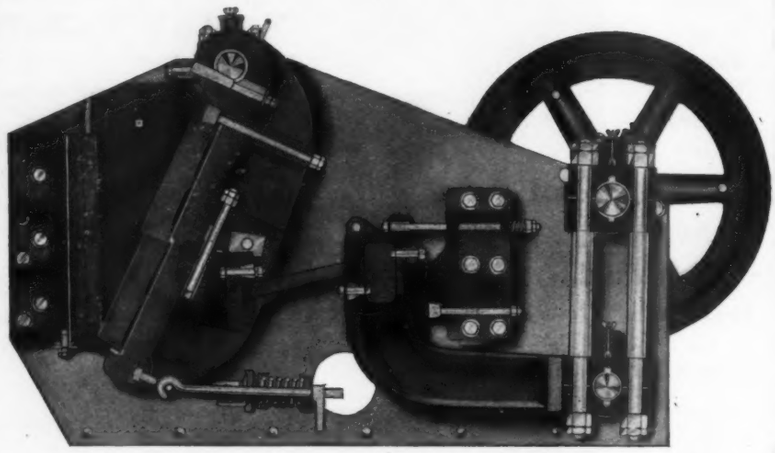

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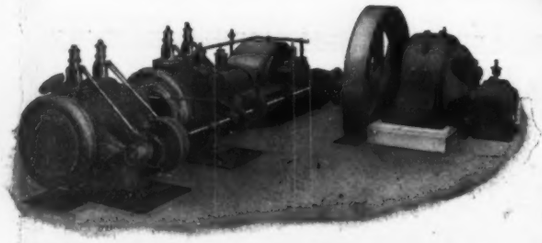

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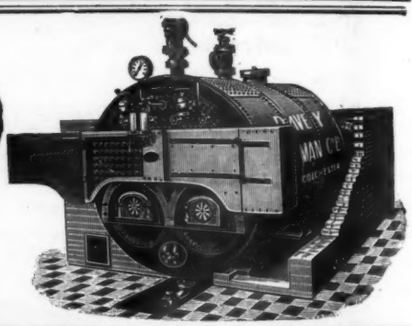

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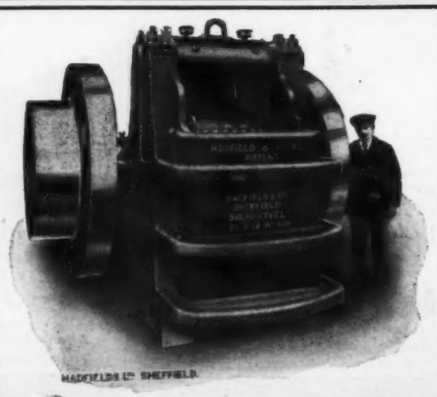

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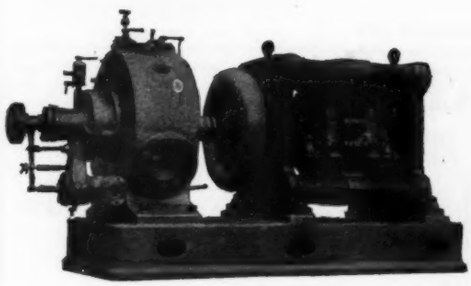

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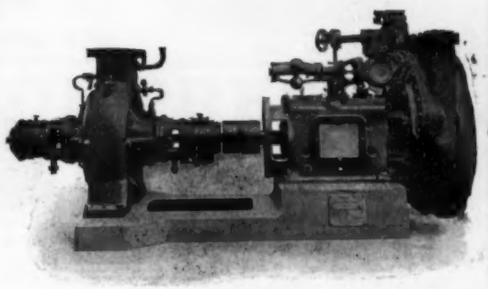

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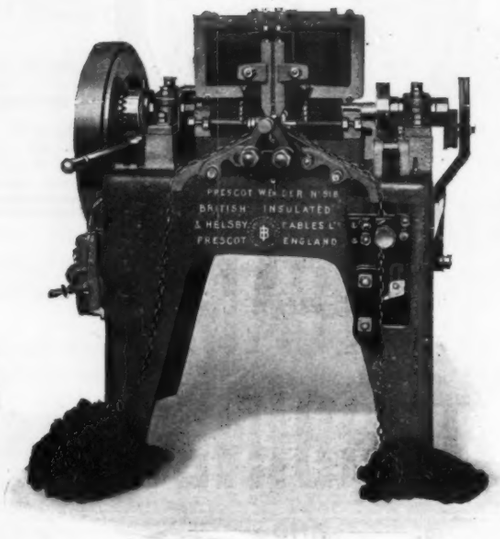

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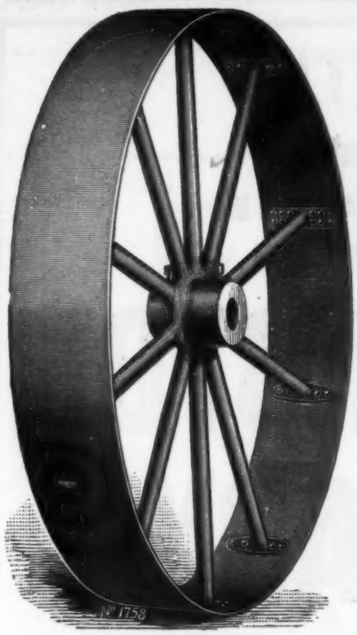

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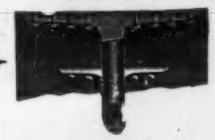

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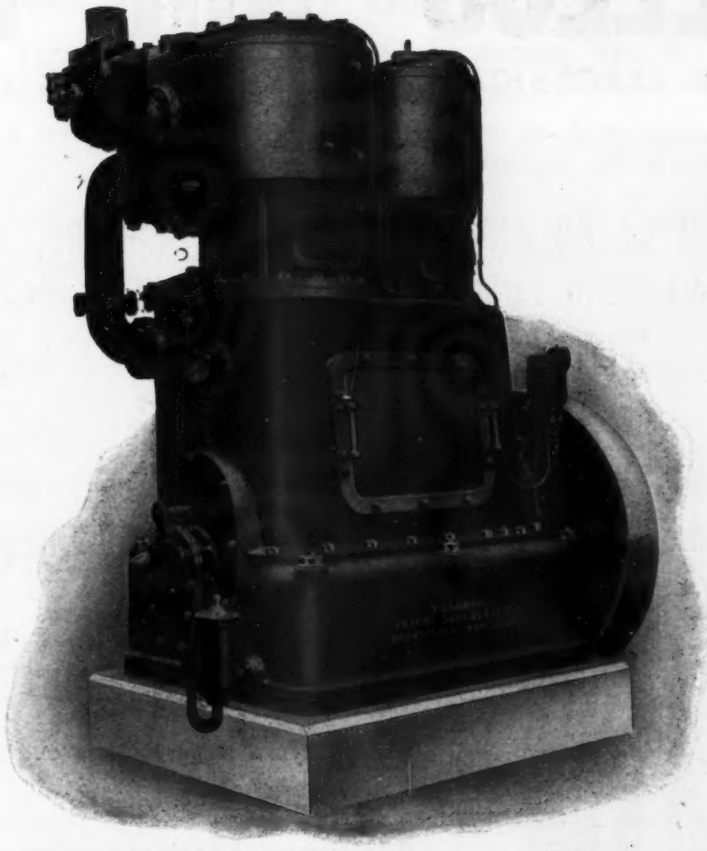

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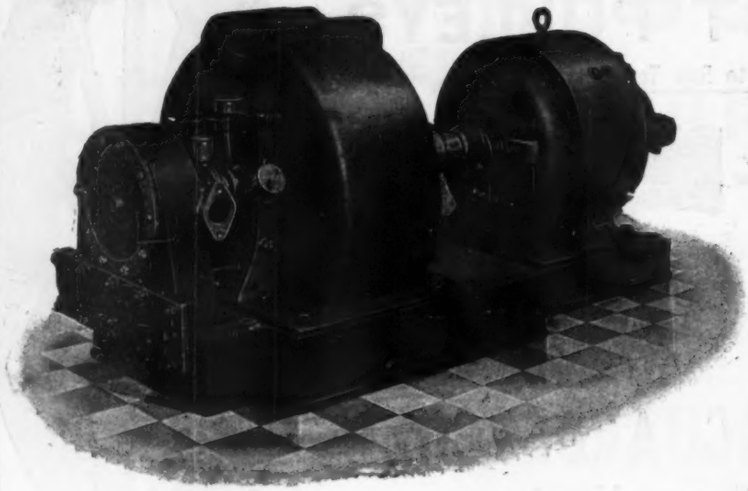

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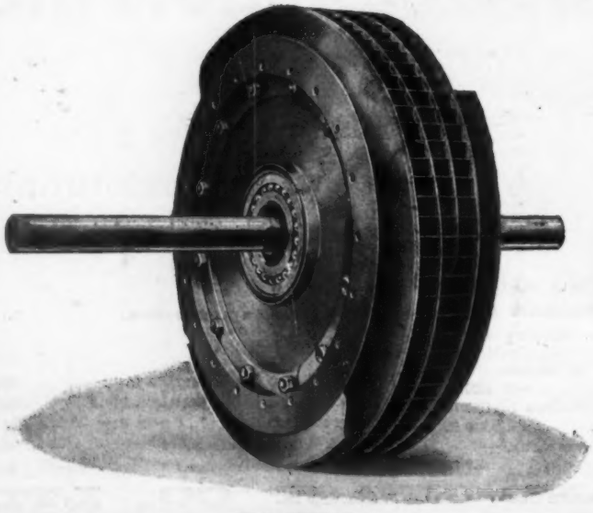

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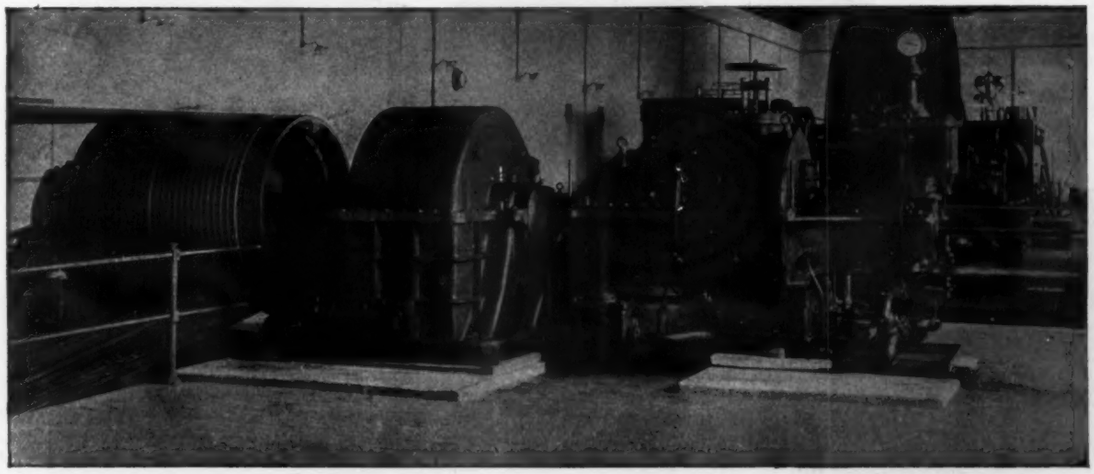

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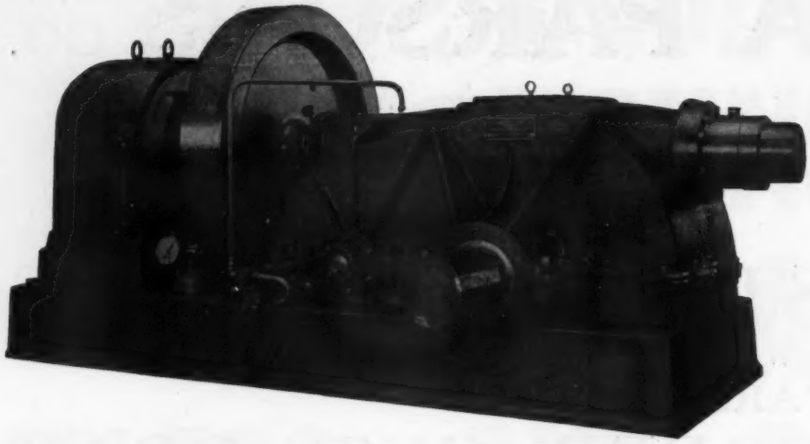

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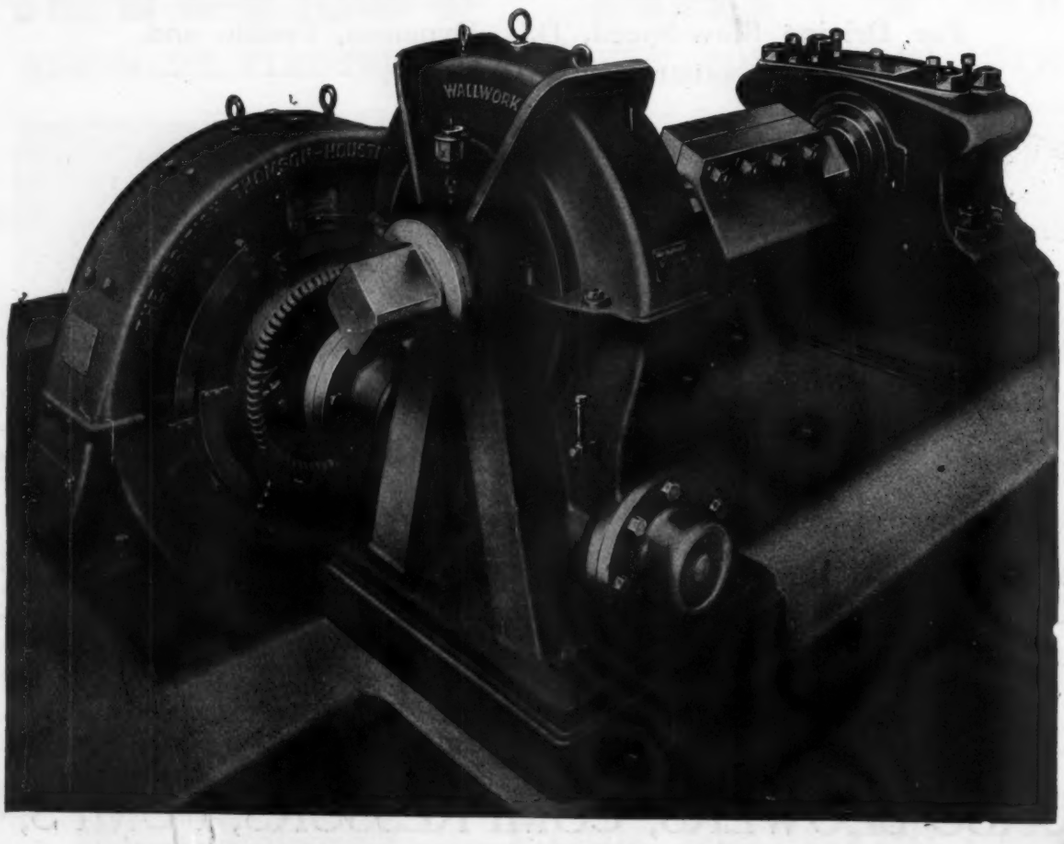

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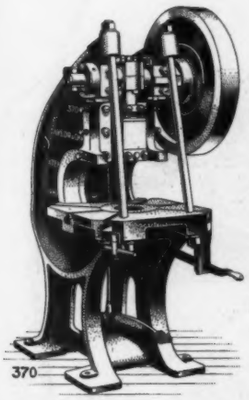
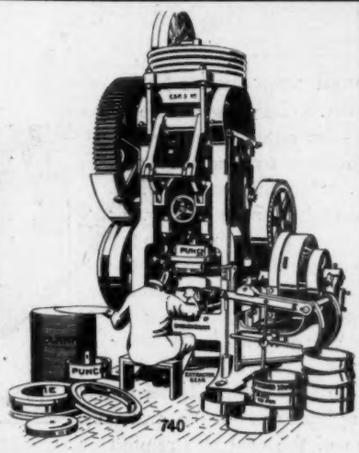
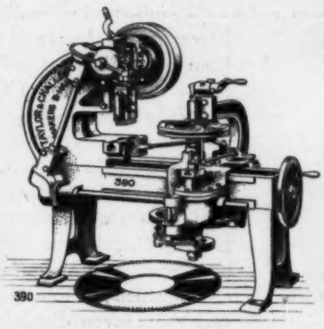


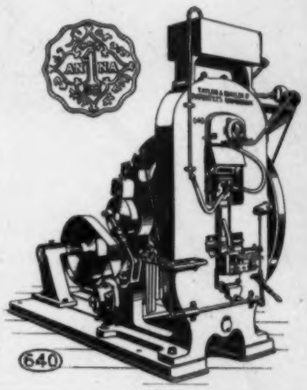
Press 370.—A quick action Press, with Automatic Clutch control. Cuts out and shapes metal blanks and components.



Size 5. Toggle Drawing Press. Draws seamless metal vessels from blanks held under pressure by the toggle motion.



390.—Notching Press. Accurately and rapidly slots core plates for electric motors.



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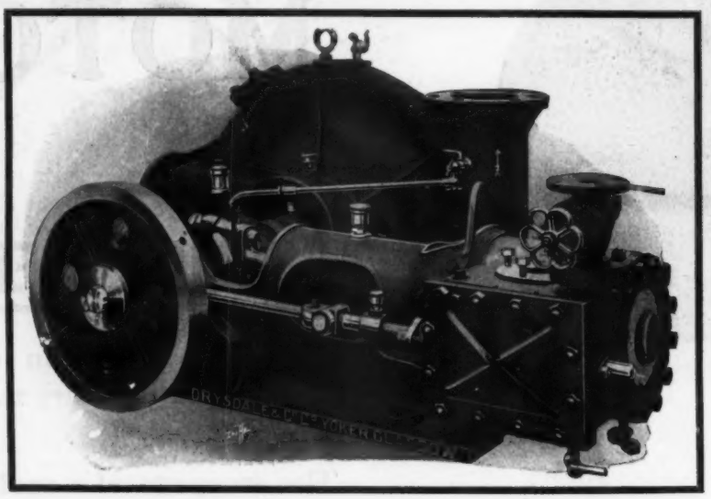

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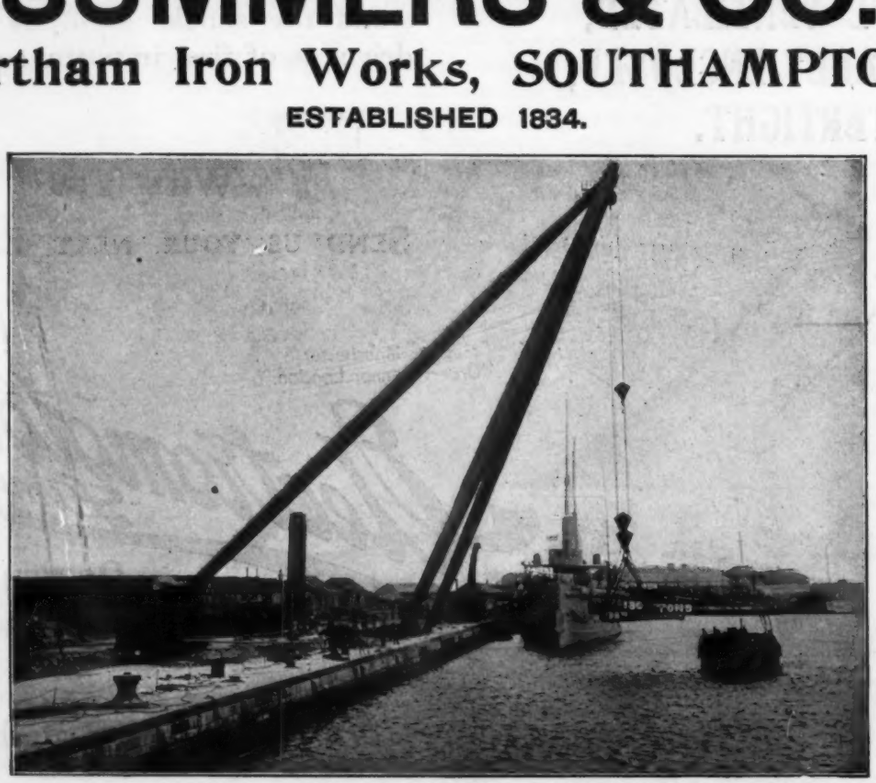

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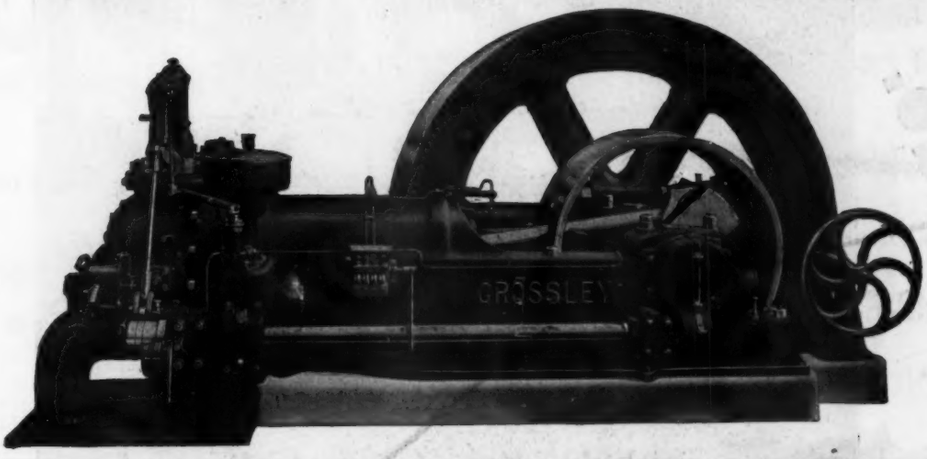

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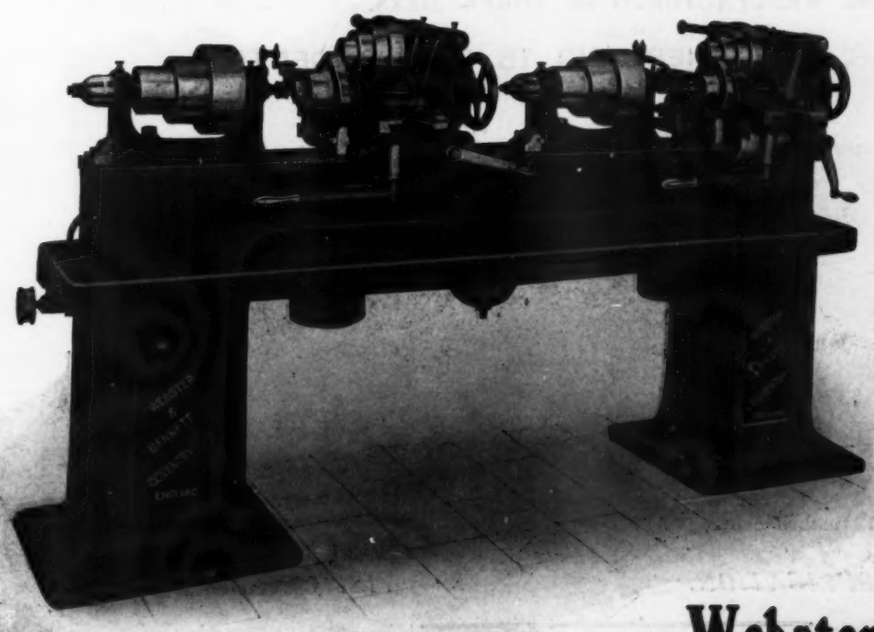

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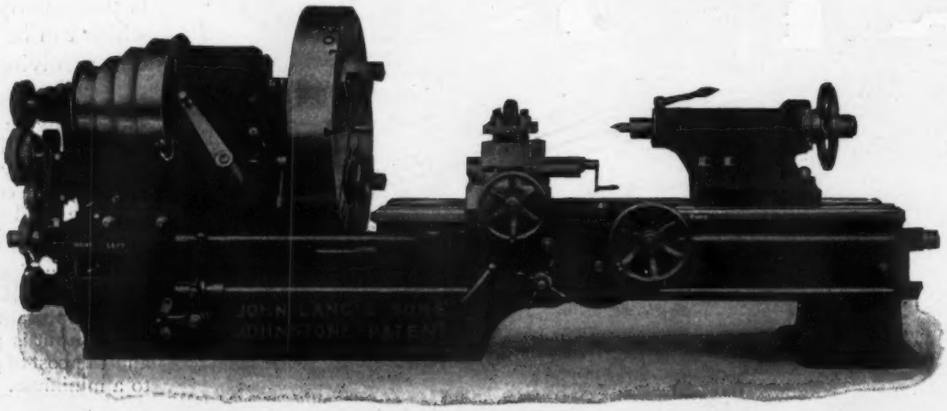

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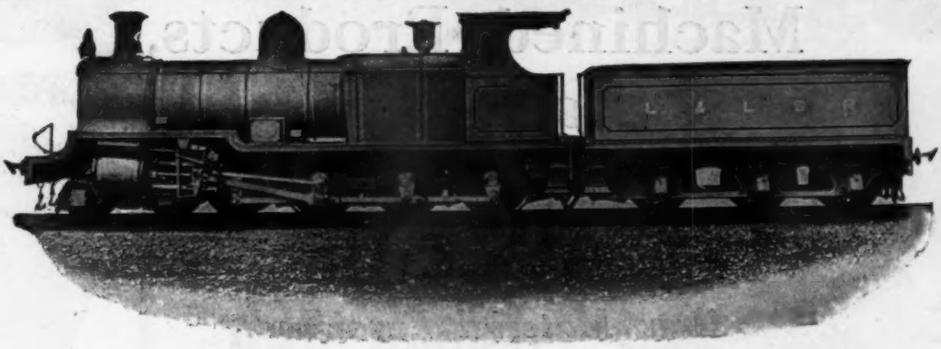

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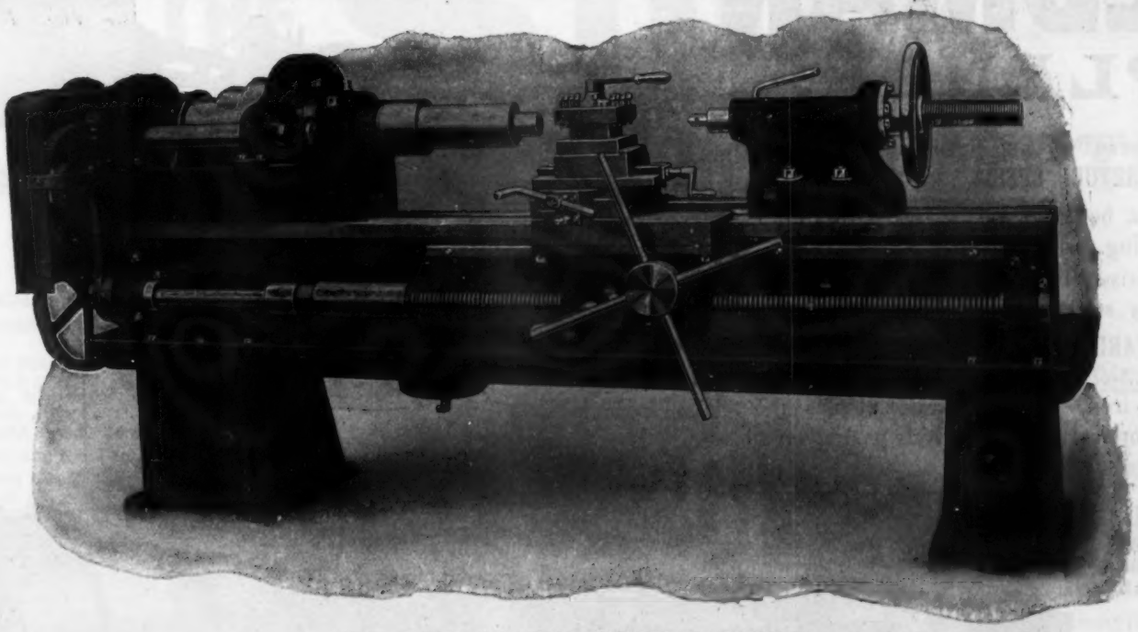

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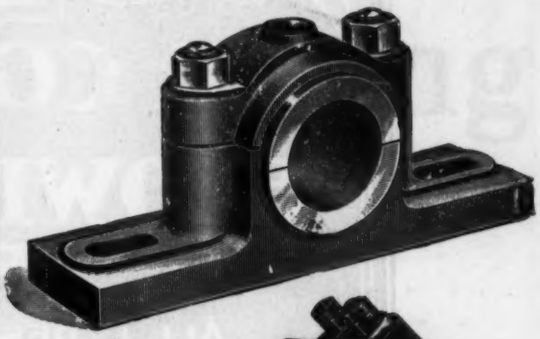

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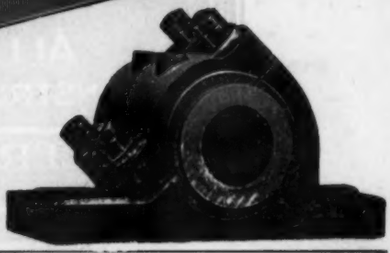

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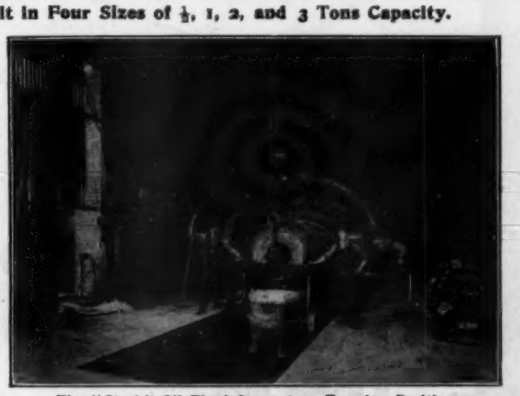

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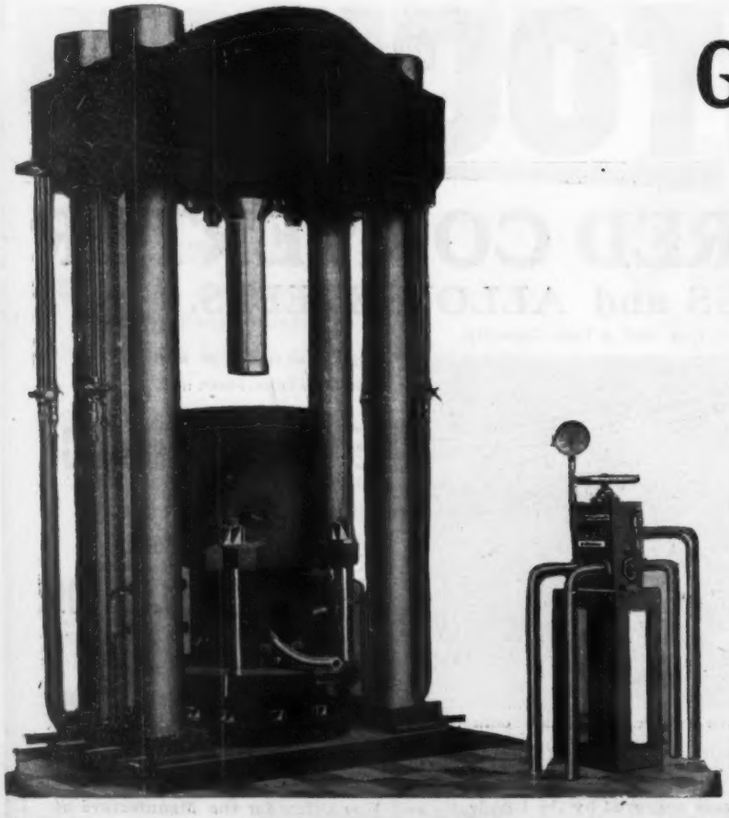

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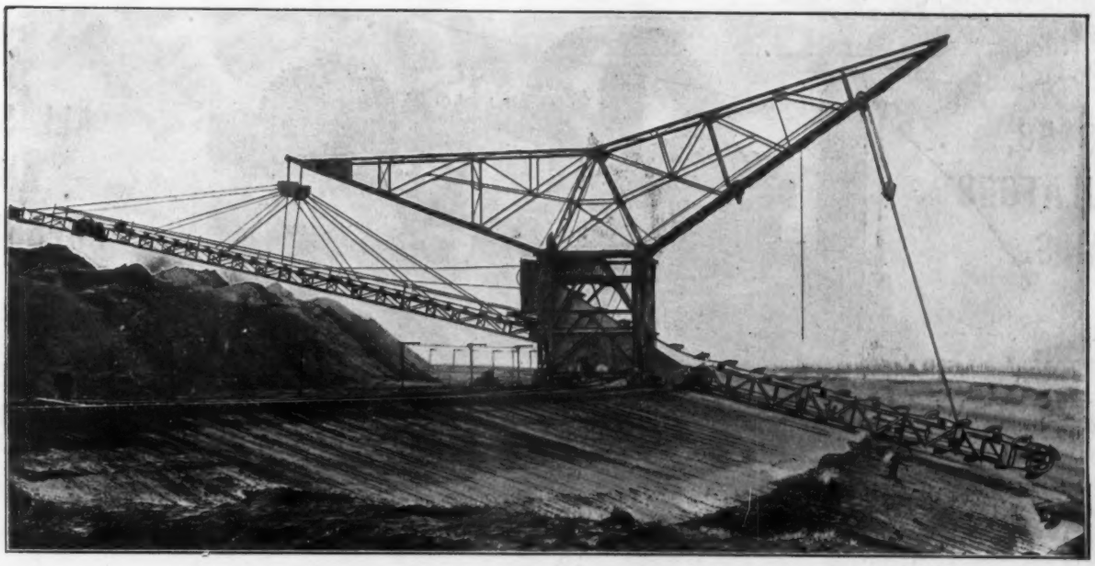

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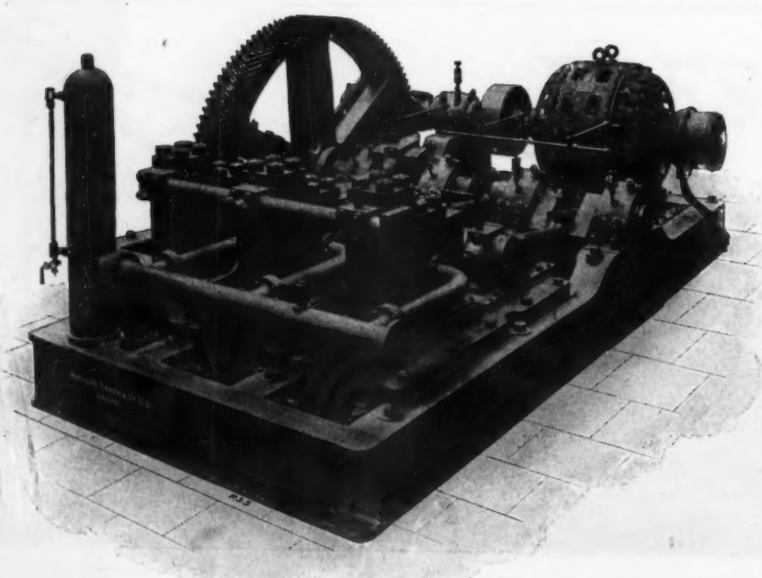

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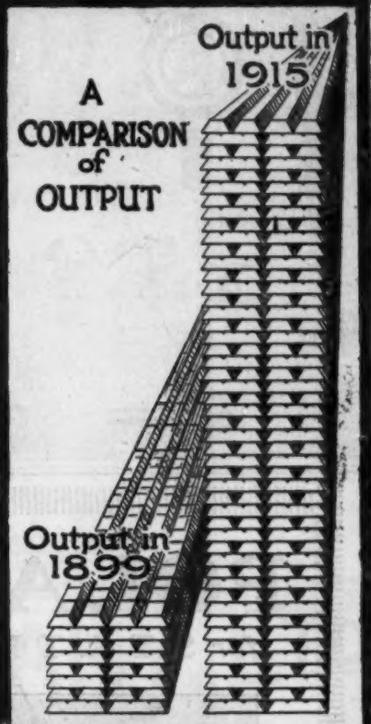

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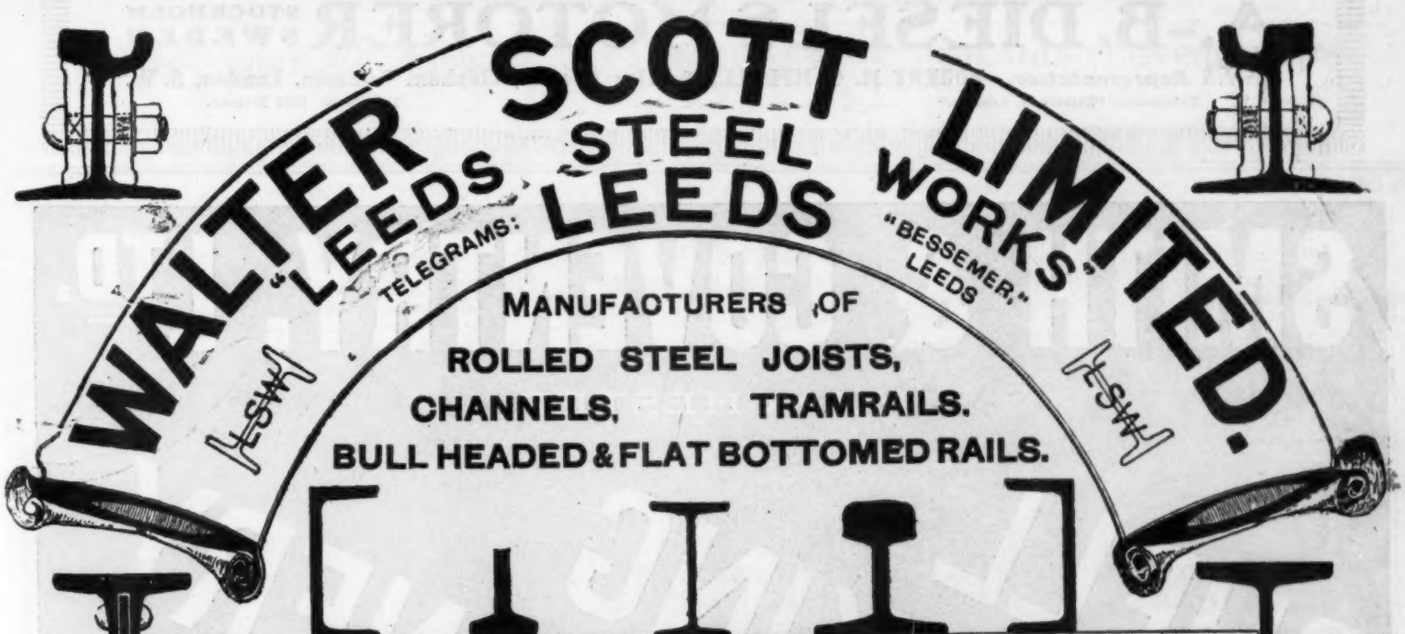

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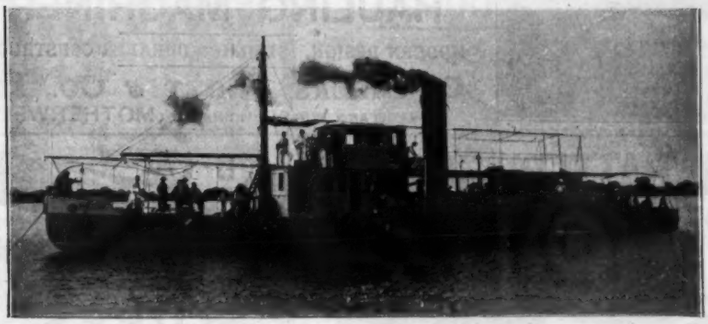

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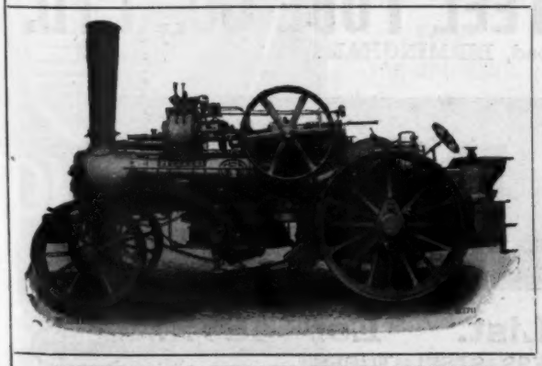

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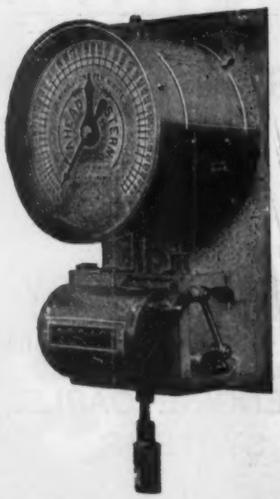

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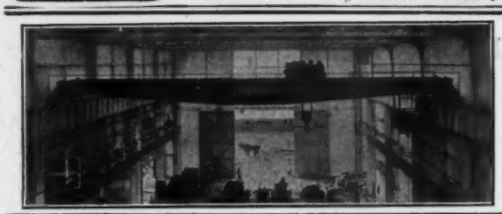

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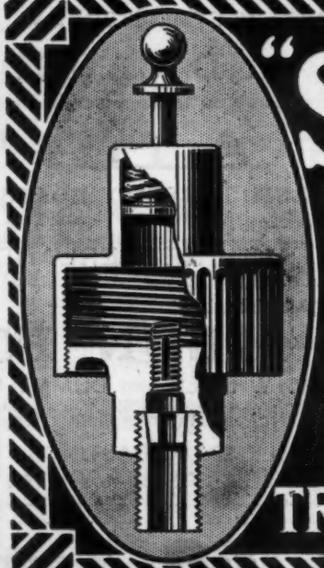

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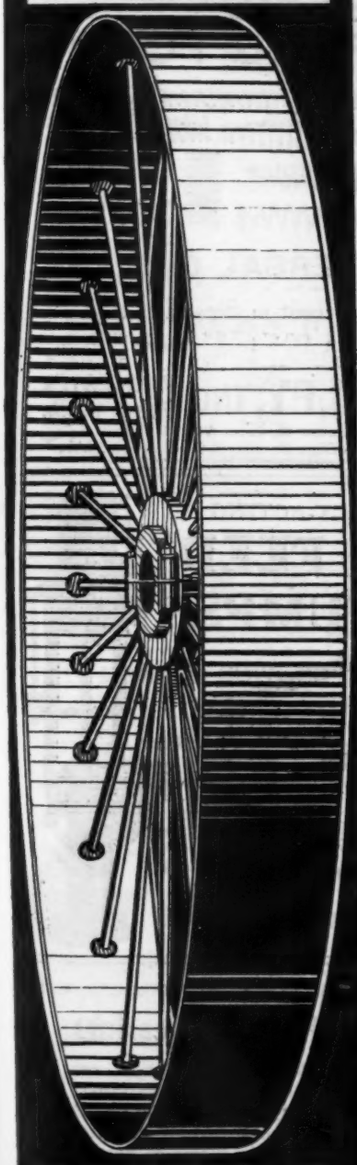

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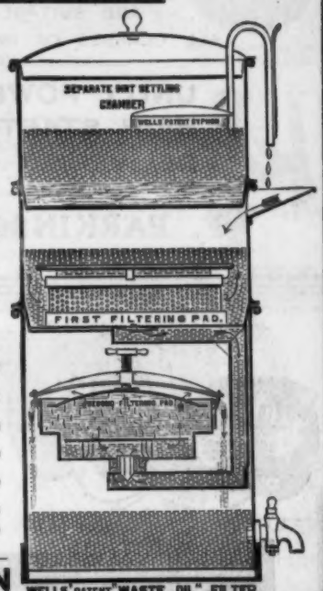

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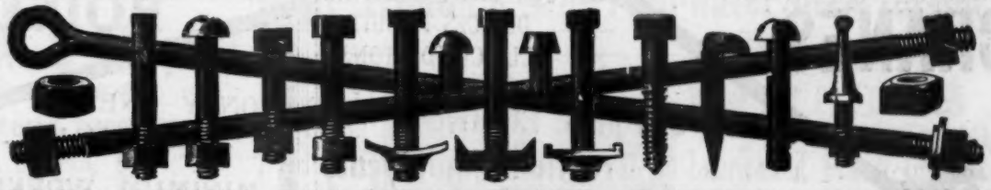

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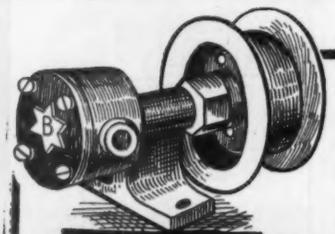

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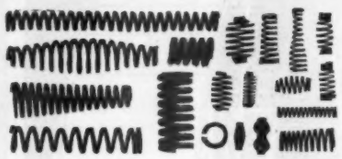

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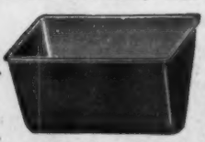

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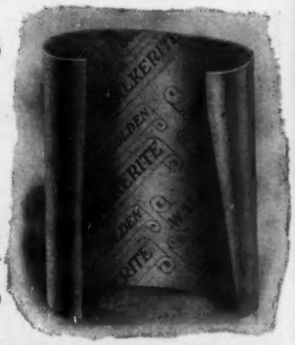

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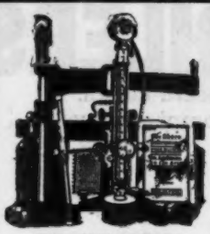

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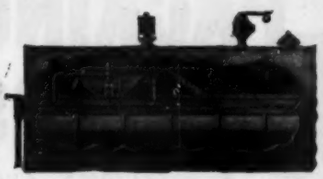

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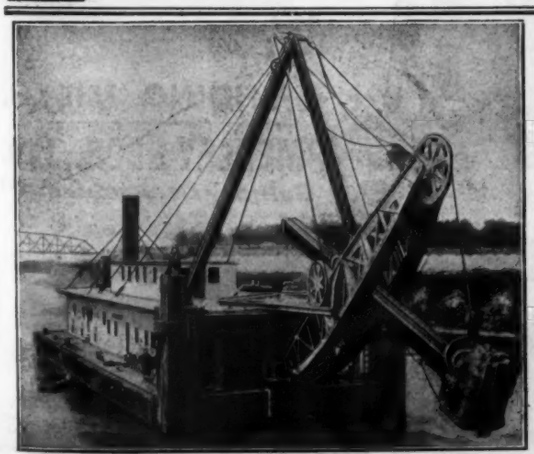

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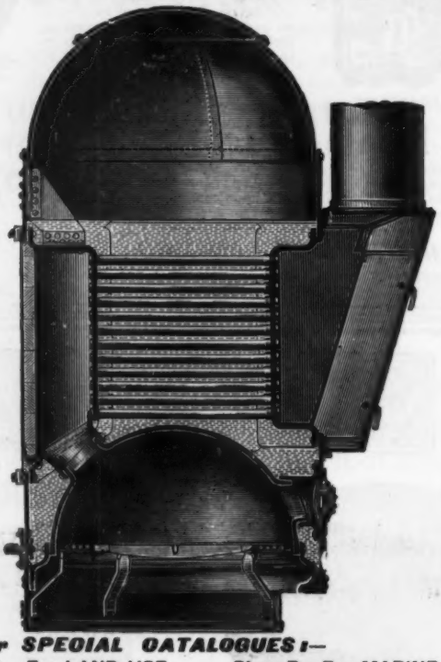

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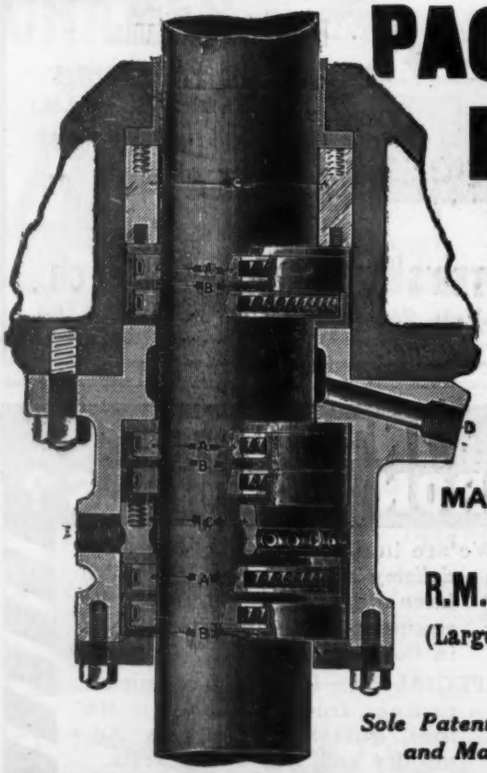

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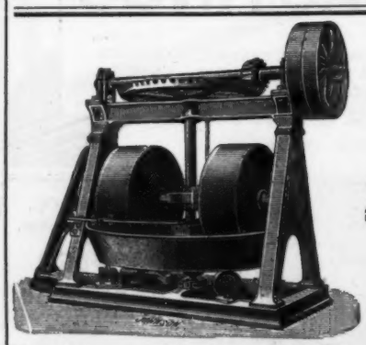

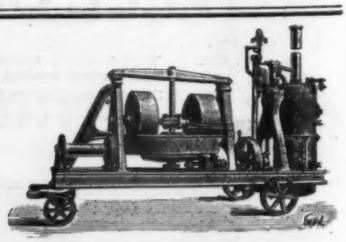

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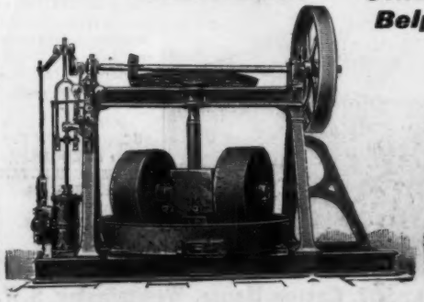

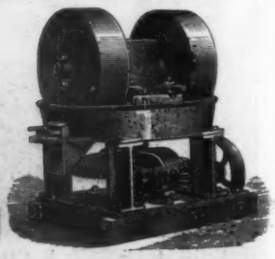

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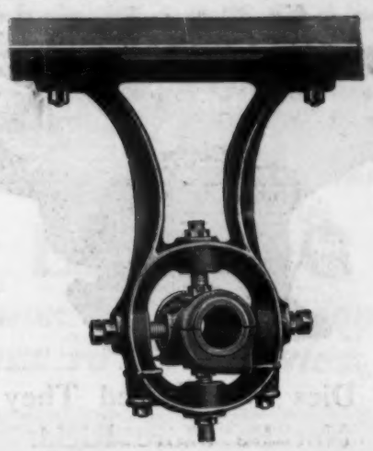

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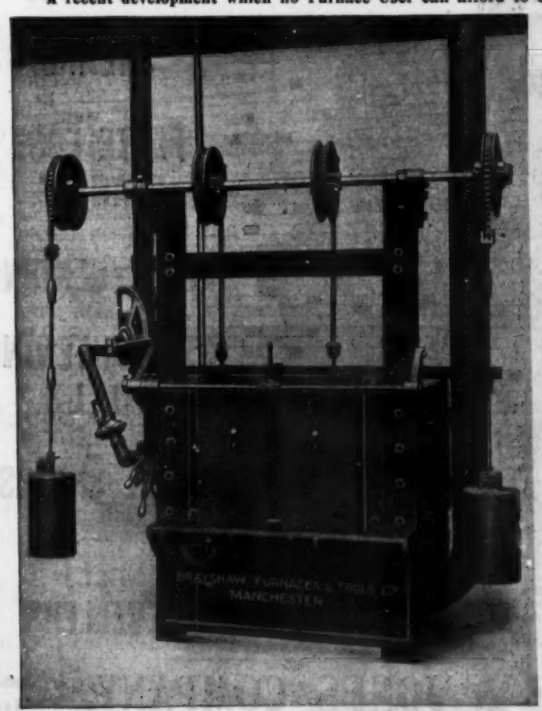

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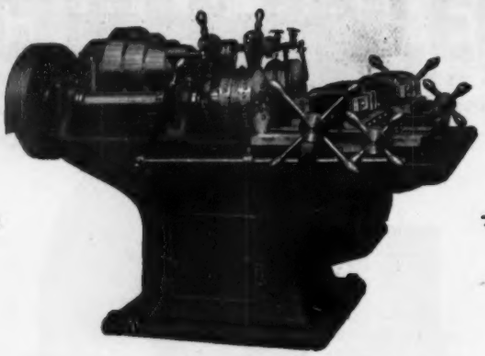

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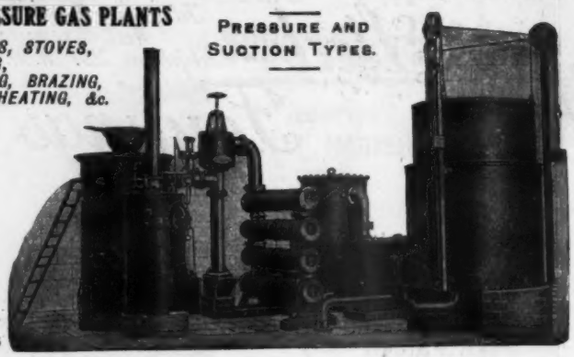

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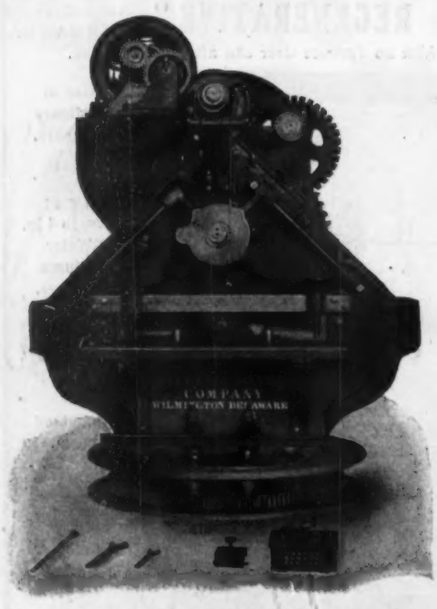

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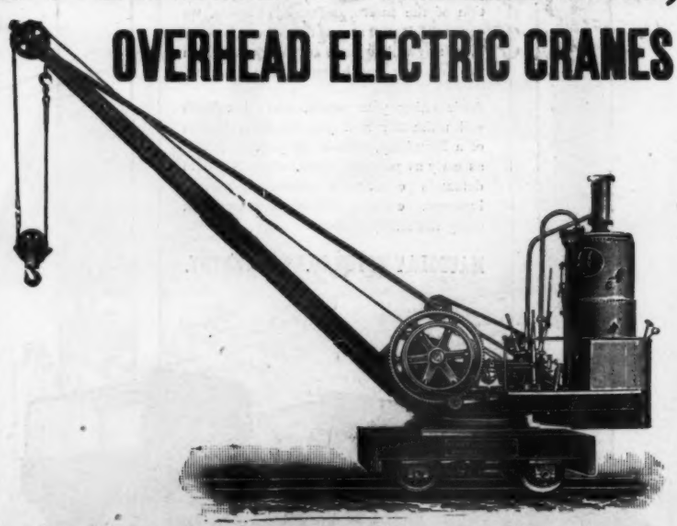

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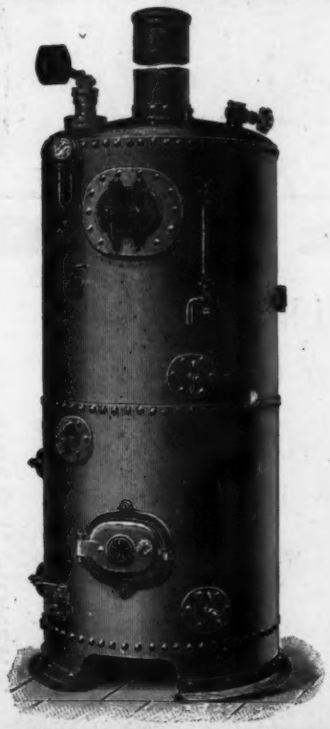

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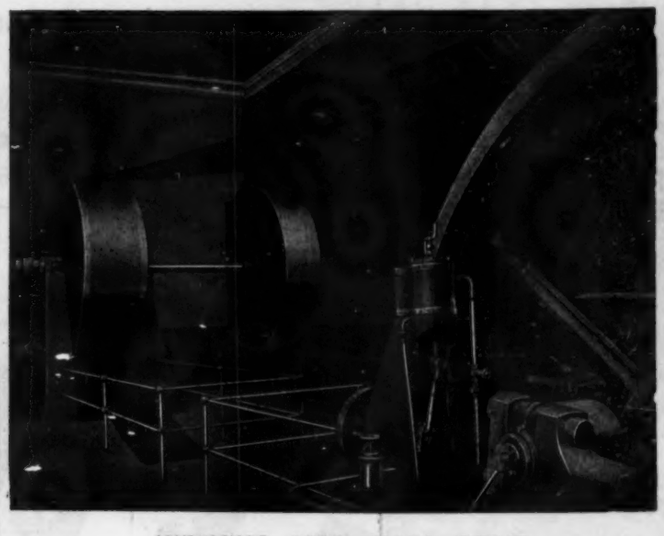

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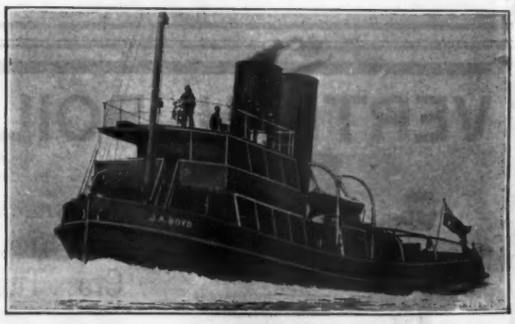

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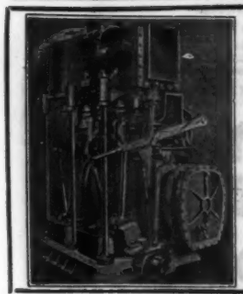

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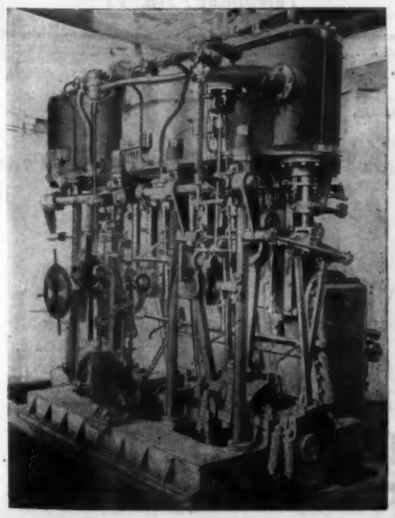

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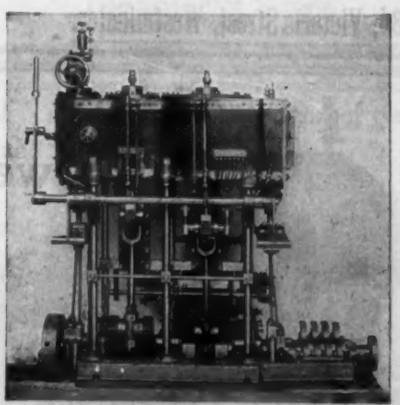

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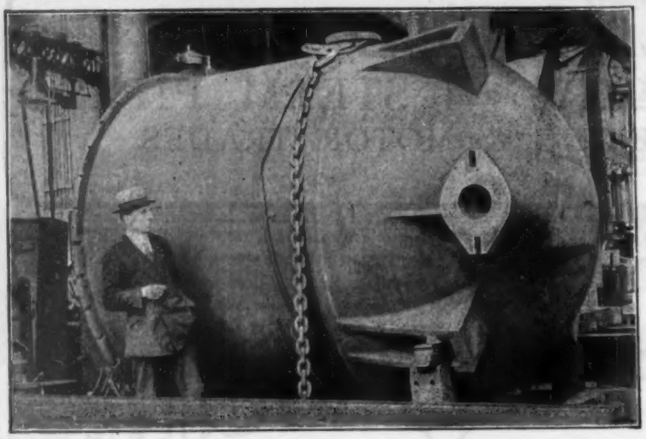

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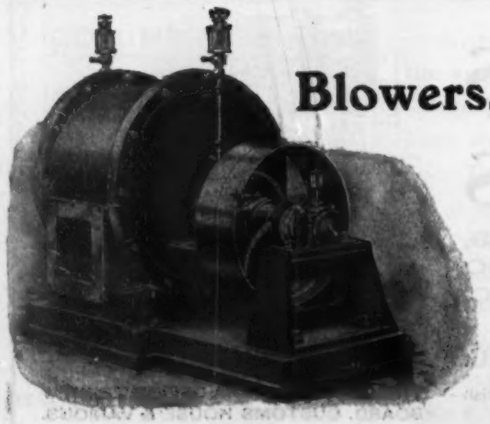

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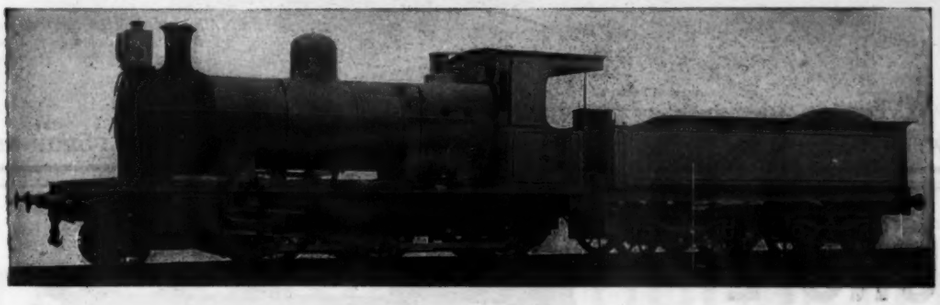

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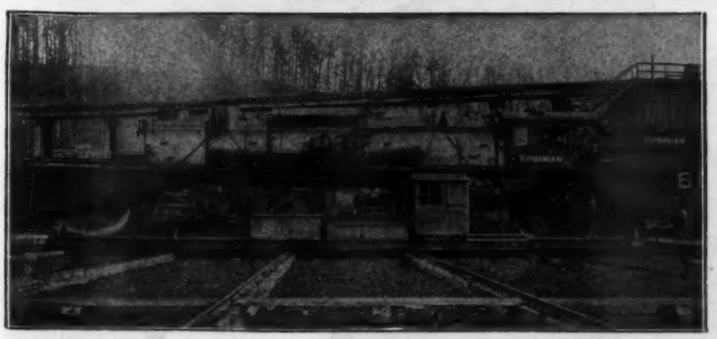

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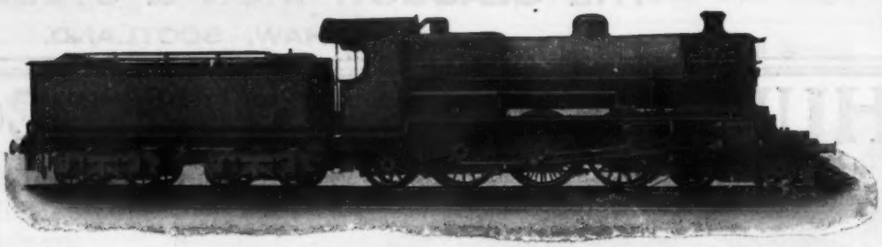

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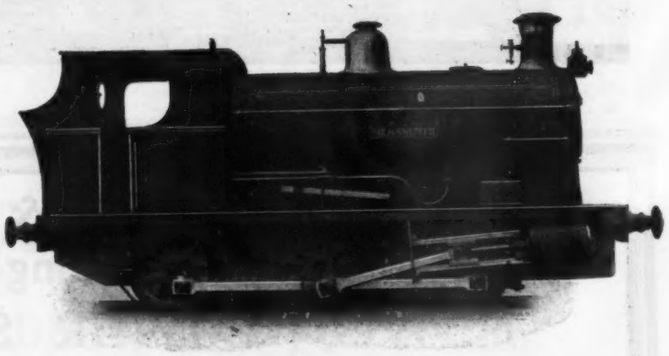

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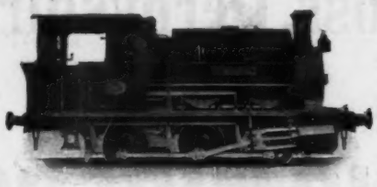
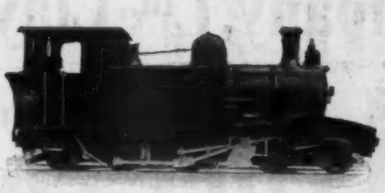

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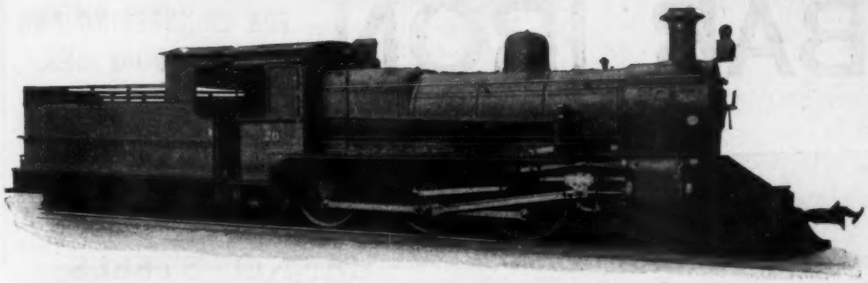

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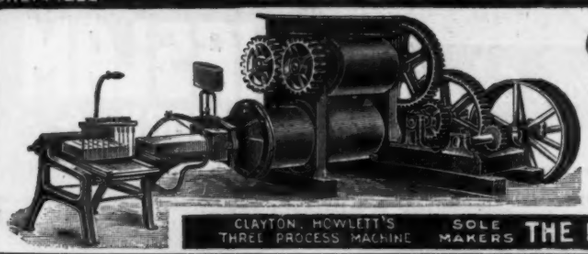

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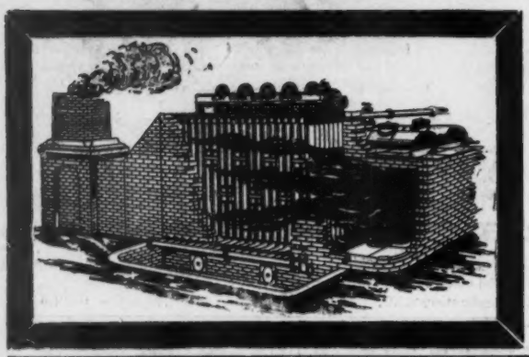

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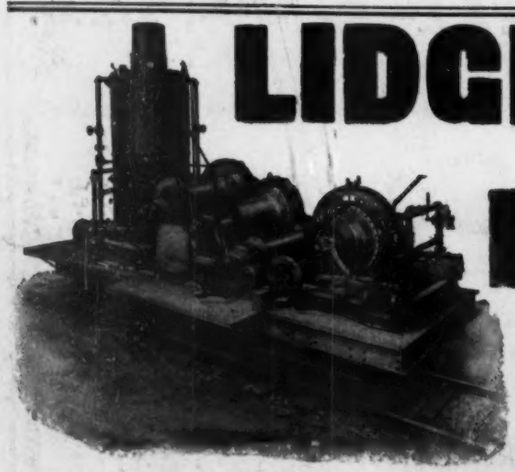

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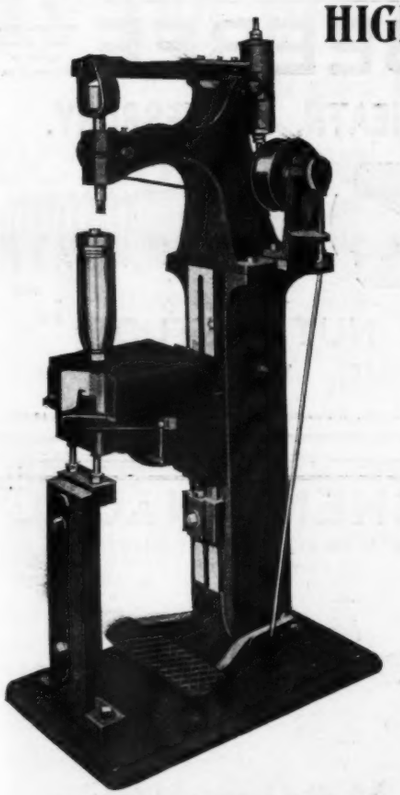

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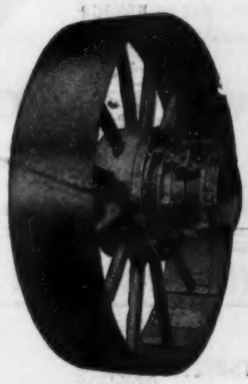

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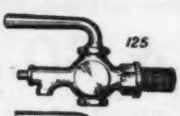

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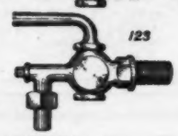

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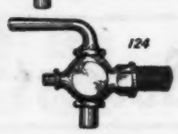

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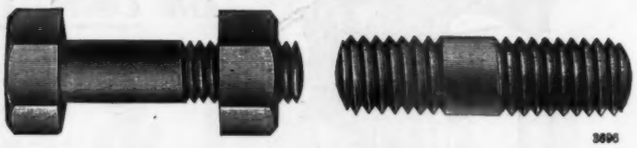

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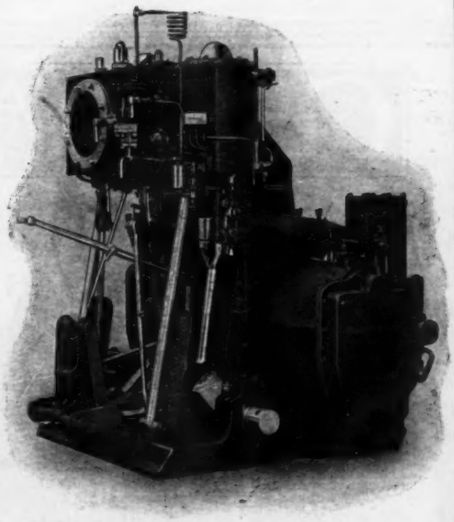

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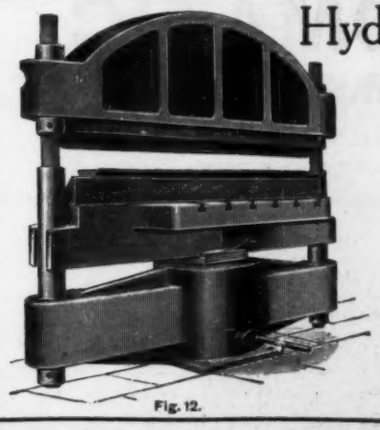

Fig. 12.

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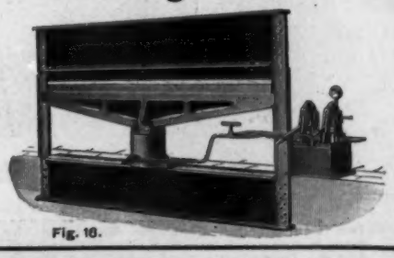

Fig. 16.

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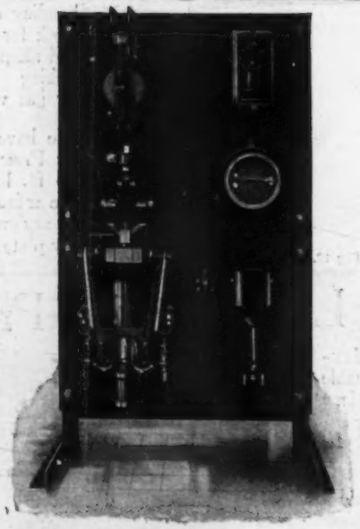

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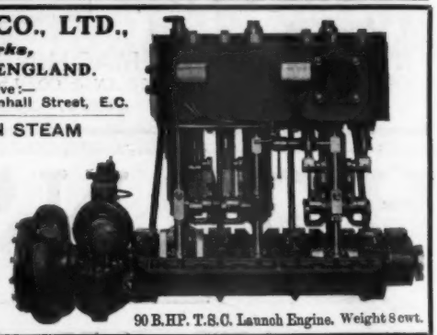

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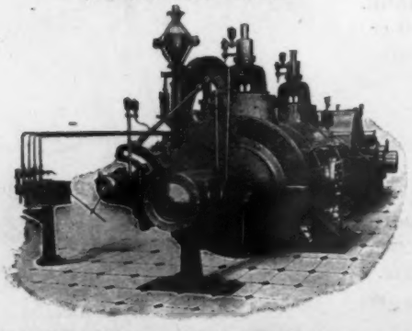

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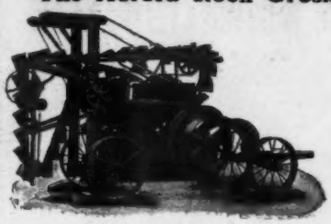

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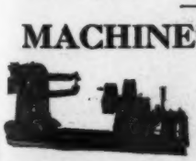

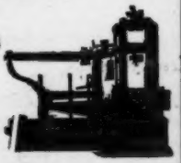

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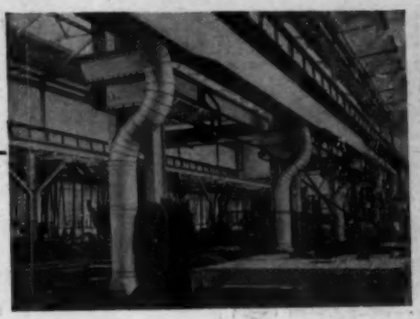

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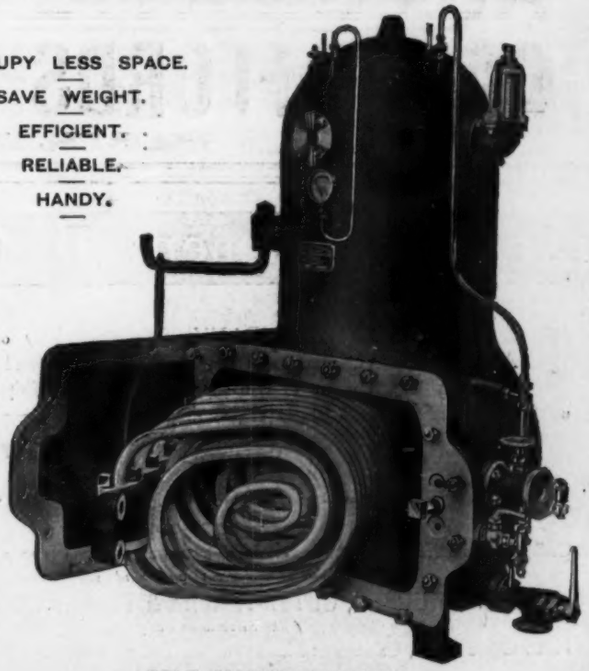

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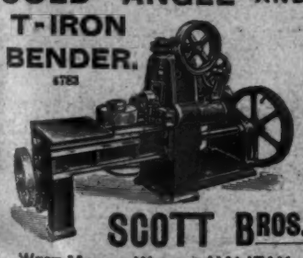

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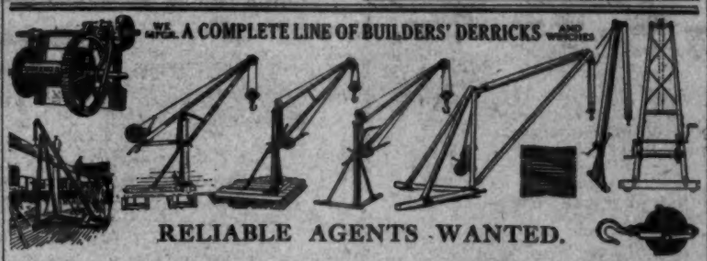

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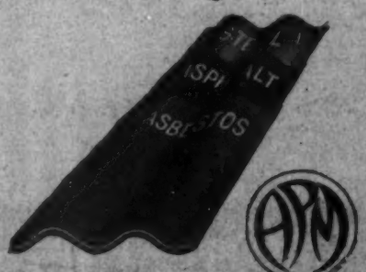

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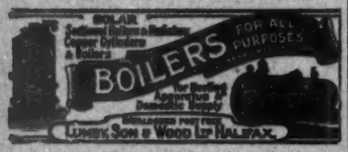

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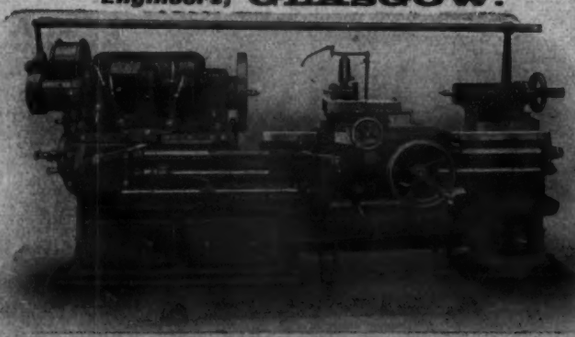

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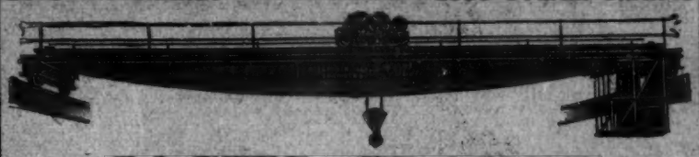

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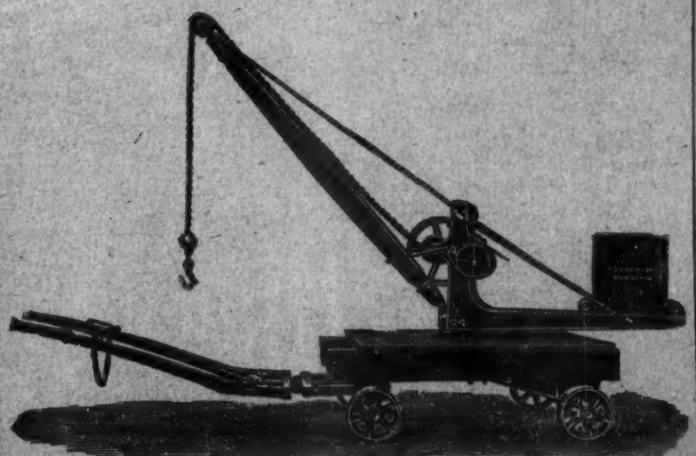

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